Chapter 3
Application Core Curriculum

1,000–55,000 psi

Abstract In detail reviewed are more then 25 major marine, industrial, and commercial complexes, explaining emerging and existing application techniques. When possible, the pros and cons of prior cleaning or product removal methods, rehabilitation, restoration and demolition practices are compared and referenced. All chapters feature an extensive application "gear-list authorization" which identify and outlines most necessary gear and tooling, including support equipment to manage purchasing, sales forces, and operators in their attempt to create a functional "gear-up list". When cross referencing between chapters "Introduction", application "register" and the "Application" core curriculum, everyone involved is equipped to interrelate independently with detailed business procedures. The book industry and job specific will introduce the all-important paper trail which begins with a job hazardous risk analysis, always followed by a trade "application review", and equipment "gear-list", guiding to a procurement-bid procedure to initiate a work order.

Pump horsepower, PSI × GPM: 1714 = HP

For intermittent duty, a gas engine must produce at minimum double the pump horsepower requirement

For continues duty, diesel engines torque-power curve at its given rpm identifies the horsepower requirement

Fig. 3a

Brick–block–stone–stucco and masonry façade cleaning, structuring, general surface preparation and restoration, hot and/or cold water, detergents 1,500–5,000 psi, at 2.5–5 gpm

Surface pasting, airborne dust suppression, applying extended service, non-film forming seal applications, biosecurity, sanitizing, deodorizing, low or high pressure, down-stream

Fig. 3b

W. Maasberg, *Commercial-Industrial Cleaning, by Pressure-Washing, Hydro-Blasting and UHP-Jetting*, DOI: 10.1007/978-0-85729-835-5_3,

injectors (Fig. 3a), metering equipment 150–3,000 psi, at 0.005–0.010 gpm plus

Clinker–slag–coke removal (Fig. 3b), kiln–boiler–furnace cleaning, thermal-hot scale removal, cracking 5,000–55,000 psi, at 2.5–22 gpm plus

Fig. 3c

Condensers or small tube heat exchangers (Fig. 3c), large tube heat-transfer units, after coolers, steam generators, three drum water tube boilers, ring exchangers, plate and frame type exchangers 7,000–36,000 psi plus, at 22 gpm plus, hand-held or automated tools, equipment

Fig. 3d

Coating–paint–graffiti removal techniques on surfaces such as asphalt, concrete, masonry, structural steel (Fig. 3d) and aluminum, high-temp industrial coating-insulation deletion method, 2,500–55,000 psi, at 2.25–25 gpm, hand-held or automated tools and equipment

Fig. 3e

Concrete-aggregate, cleaning–cutting–scarifying (Fig. 3e), heavy demolition, restoration and finishing, concrete removal-cleaning procedures on industrial equipment and vehicles with UHP equipment 10,000–45,000 psi, at 2.25–60 gpm plus

Fig. 3f

Dry–wet vacuum applications (Fig. 3f), dredging, emulsifying sludge, hydro-excavation, gravel cleaning, pumping fluids, dust-refuse or bio-product loading, transfer or removal of industrial product 3,000–7,500 psi, at 5–45 gpm plus

Fig. 3g

Duct-work, canopy hood installation cleaning (Fig. 3g), acid and sanitary treatment, pipe cleaning prior to installation of liner systems and the coating of interior steel-iron pipes (∅) 2,500–10,000 psi, at 5–45 gpm plus

Fig. 3h

Directional–horizontal underground pipe installations (Fig. 3h), water well cleaning, water jet-grouting, pile driving 3,000–8,000 psi, at 10–45 gpm plus

Expansion-control joint cleaning on rigid pavement, sidewalks, decking, tank and pool construction, grout–membrane–plastic–rubber–elastic removal (new product installation) 3,000–14,000 psi, at 5–22 gpm

Filters, screens, felts, bag-house units, trays for catalytic-cracking, vacuum suction rolls radiators-fin-fan (exterior), air-preheater baskets, staggered channel, wire mesh-plate-vane mist eliminators 2,500–10,000 psi, at 5–45 gpm, hand-held or automated tools and equipment

Fig. 3i

Flatwork-surface cleaning (Fig. 3i), gas stations, banks, restaurants drive-thru, machine shops, warehouse structures, parking garage areas, and hangar facilities, vehicular–pedestrian tunnel

surfaces, etc. 2,500–7,500 psi, at 5–45 gpm plus, hand-held or semi-automated tools and equipment

Hazardous industrial waste recovery and soil treatment, asbestos, radioactive trace element remediation (Fig. 3j), vehicular accidents and cleanup of crime scenes 1,500–14,000 psi, at 2.5–45 gpm, including UHP services, hydro-vac and HAZMAT operations

Fig. 3j

Hydrostatic testing of boilers-steam generators (Fig. 3k), gas and vacuum vessels, towers, tanks and nondestructive leak testing hydraulic systems 500–45,000 psi, hot or cold charge water volume delivered by plant supply or centrifugal pump

Fig. 3k

Mold remediation, disaster cleanup, water damage-sludge removal, insect–pest suppression, odor–stench control 500–7,500 psi, 2.5–45 gpm plus, hydro-vac systems, rotary surface cleaner, turbo nozzles, abrasive injectors, etc.

Oil lube systems (industrial), tanks, oil compressors, hydraulic equipment services, light oil jetting, 1,500–4,000 psi; the gpm performance may vary as to nozzle configurations applied befitting the unit's size and type.

Ornamental–monuments, city fountains, theme-amusement parks (Fig. 3l) hotel and municipal pools, aquatic–marine pools and tanks 500–5,000 psi, at 2.5–10 gpm according to tool and application

Fig. 3l

Polishing, etching, metal burr-flash removal (Fig. 3m), weld seam polishing, surface modulation 3,000–45,000 psi, at 2.5–22 gpm, utilizing UHP technology and hydro-abrasive blast equipment

Fig. 3m

Sewers, laterals (Fig. 3n), culverts, sumps, industrial pipe cleaning, pipeline cleaning and high-Pressure-water abrasive cutting applications 3,000–45,000 psi, at 2.580 gpm plus.

Fig. 3n

Steam–vapor–gas–flue stacks, industrial elevator shafts, laundry, garbage chute cleaning and sanitizing 3, 000–7,500 psi, at 5–60 gpm, various rotating and centered 2D–3D tank cleaning equipment

Stationary—portable, industrial–commercial equipment, vehicle fleets, rail–car (Fig. 3o), truck–trailer–tanker trucks, hot and cold water, detergents, manual—automated equipment 2,500–7,000 psi, at 5–45 gpm,

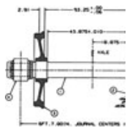


Fig. 3o

Tanks, vessels–autoclave (Fig. 3p) container cleaning, volatile substance removal and effluent separation 2,500–22,000 psi, at 5–95 gpm, hot and cold water, detergents, manual–automated equipment

Fig. 3p

Hydro-abrasive blasting 3,000–6,500 psi (Fig. 3q), steel cutting-demolition applications, underwater hydro-blasting and dredging 3,000–45,000 psi, at 2.5–45 gpm

Fig. 3q

Wash water control, recovery, filtration, recycling, wastewater reclamation technology, evaporation, hazardous materials cleanup, chemical rinse aids 2,500–7,500 psi, at 5–22 gpm

Wood structures–roofs–decks–landings–fencing (Fig. 3r), wallboard cleaning, facilitating coating painting-preservation procedures, vinyl and aluminum siding cleaning, tile-asphalt roof cleaning 500–5,000 psi, at 2.5–5 gpm

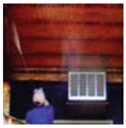


Fig. 3r

3.1 Brick–Block–Stone–Stucco and Masonry Façade Cleaning, General Surface Preparation–Restoration

On restoration or construction sites, most of us have witnessed brick cleaning efforts displaying a great dust cloud generated by dry abrasive blast operations. These clouds prove the shortcomings of an abrasive blast material which is either too fine, coarse or too sharp, hence possibly destroying brick glaze, mortar and masonry surfaces. The reuse of abrasive materials, a not so uncommon practice among contractors also furthers an uneven porous surface appearance and aided dust development. In addition, the developed dust clouds present a tremendous health hazard to all involved, including pedestrians in the immediate and distant vicinity. Wet abrasive blast methods, utilizing an air blast procedure employing a water mist to control dust expansion can discolor brick surfaces, thus requiring a secondary wash-down via high-pressure water resulting in mud accumulations unsuitable for delivery to a storm drain system. For cleaning purposes and in spite of its shaky validity, the abrasive soda-blast technique in operation is also identifiable by a possibly enormous white dust cloud spewing baking soda, unidentified coatings and the removed brick–concrete surface film (glaze) into the atmosphere creating its own specific hazardous environment is quite often applied for graffiti removal applications. Regardless of the so-called abrasive or micro abrasive cleaning method employed, it is a fact that adding a profile by disturbing the underlying surface being cleaned is not an acceptable criterion and can be catastrophic when applied to historic structures, stone and aged masonry within a cleaning or rehabilitation procedure. One will only hasten the attrition to surfaces substrate produced by soot, salts, acids, weather cycling, water, moss and/or possible mold recurrences. Sealing these failed and most likely contaminated surfaces with liquid sealers or epoxies only delays the deteriorating process and does not represent a restoration or cure-all for past environmental impacts.

The last 40 years, unrivaled national and international restoration and/or cleaning successes stand in opposition to overzealous sales efforts by service

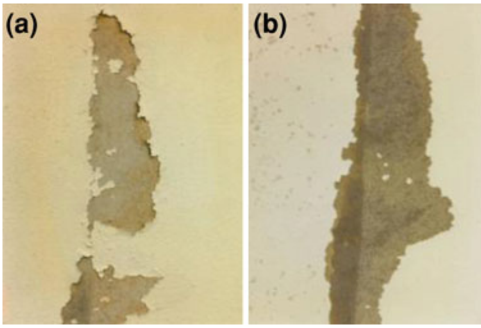


Fig. 3.1 **a** Drywall before, **b** drywall after

providers, architects and restoration–preservation–rehabilitation officers. Some will offer chemical and abrasive cleaning solutions by overstating their novice opinion in suggesting that competitor's high-pressure water cleaning operations are damaging to honed, textured or polished finishes on brick, block, exterior dimension stone, friezes, stucco, architectural masonry, composites and grout surfaces. Microscopic test procedures before and after jetting processes on these various surfaces have proven this opinion not only wrong, but also misleading. Opponents are still not aware that for instance, 3,000 psi at 5 gpm can be utilized to remove failing coatings from wide-ranging drywall surfaces with minimal surface wetting, avoiding the puncture and peeling of underlying drywall paper and gypsum (Fig. 3.1a, b). Also within this performance level a 45° fan nozzle at a 2′ standoff distance is deemed perfect to gently remove residue from this operator's fingernails. Further, microscopic tests have also revealed the importance of exploiting a technically matured fan nozzle design with a gpm–psi configuration specifically addressing the individual surface criterion encountered. A one size fits all nozzle application does not exist. Adhesion–bond–absorption–adsorption and the possible static attachment ability between a surface–substrate, deep-set stain or soot on encountered surfaces and architectural features under examination must first be determined (mildew, patina, dirt, soot, coatings, graffiti, chemical haze, oils, urea, salts, efflorescence-calcium carbonate, etc.). Once an optimal technical removal criterion is established a gentle environmentally correct and superior job completion is the positive aspect of any high-pressure water cleaning or restoration effort. This is especially a time-saving method when deep seated stains are removed following high-pressure water cleaning procedures utilizing poultice techniques under standard guide ASTM C-1515, and/or possible chemical and bacterial concentrate or liquid seal applications. To perform standard chemical application methods the economical exploitation of various metering devices is also of essence. Combining today's high-pressure water variables and cleaning solutions with a refuse pickup, filtration and recycling capability most often renders past methods and preservation technologies too expensive or obsolete.

Today, contractors cleaning exterior building façades and architectural surfaces for aesthetic reasons (Fig. 3.2a, b) speak to and offer application expertise to achieve the first line of defense against potential negative environmental, traffic, human and

Fig. 3.2 **a** Masonry cleaning in progress

possible vandalism impacts which can include offering a regular maintenance program for normal care to control surface staining events. This required expertise differs substantially between new and historic structures. The façade inspection consists of a general inspection and detailed inspection in areas where the greatest exposure, surface contamination and possible damage exists. As part of a façade inspection, ASTM E2270-03 for unsafe conditions requires the review of an existing service history. Evaluating the masonry epoch (Fig. 3.3), type and prior applied cleaning techniques, their successes, or appearing damage which sometimes support accelerated deterioration of soiled surface substrate will subsequently guide every future cleaning or rehabilitation procedure. Besides environmental influences damage can be visibly identifiable by recognizing loss of surface stability and glaze, architectural detail due to prior aggressive chemical or abrasive cleaning techniques which also result in advanced surface friability, reduced adhesion and tensile strength of mortar and grout or a advanced interior degradation of brick, terra-cotta, masonry and block structure due to the remaining active chemicals, biological and/or acid contaminations. When these types of failing conditions are encountered the chemical cleaning and physical scrubbing technique is deemed obsolete avoiding further surface deterioration. Surfaces susceptible to physical–mechanical chemical or forces are cleaned with neutralizing pressurized water only.

When determining the PSI requirement to break adhesion or produce solubility of a specific product and surface soiling, the protection of the fragile surface is achieved by reducing the fan jet's water volume (mass) to the point where a substrate surface modulation or abrasion by water velocity is null and void. The square footage cleaning performance is determined by fan jet coverage and standoff distance. Pressure washing equipment operating at 5 gpm, can also apply dual 2.5 gpm fan jets either individually or overlapping attached to a nozzle carrier (Fig. 3.4). Operating industrial equipment will permit the utilization of (Fig. 3.5a, b) multiple gun operators, accelerating job completion.

Fig. 3.3 Brick variations

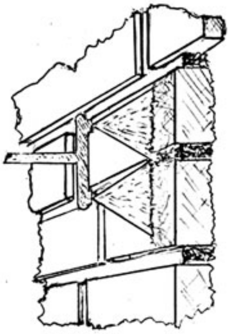


Fig. 3.4 Dual 2.5 gpm fan jets

Fig. 3.5 **a**, **b** Duel gun cleaning operations

The variables of a customers intent to clean or restore, and/or his comprehension of the naturally present patina (Fig. 3.6) including architectural character of his building components must be understood by contractor and architects alike. They must make sure that all cleaning and restoration efforts are performed to the mutually derived and agreed final visual appearance and necessary technical aspect. A customer's possibly varying opinion or his second-guessing the effects within a jobs progression and subsequent appearing visual results while cleaning operations are still performed must not ever undermine the contractual status. Therefore, this situation demands a prior correct assessing of surface dilapidation, contamination and discoloration encountered.

Fig. 3.6 Brick patina

Fig. 3.7 Water-abrasive cleaning

Various possible brick–block and stone surface manifestations can sometimes be suggestive and incorrectly preconceived by prospective customers when relating to a final surface appearance found sometimes unattainable by solely utilizing high-pressure water. Often customers' visual guidelines or expectations are derived from past witnessed favorable surface appearances produced by abrasive and over aggressive chemical cleaning operations. A practical "demonstration" creating various test patches is highly recommended satisfying all involved by projecting an overall final appearance which permits also a closer understanding to required tool selections, time necessities or constraints and application processes.

Contractor's expertise will include the recording of the visual results and presentation of long term effects by extended weathering and aging of these test patches. Extensive rehabilitation procedures will almost always allow for test periods between 6 and 12 months, generally the longer the better.

Coated, discolored or aged deteriorated brick, block, concrete and masonry surfaces often identify their environmental and structural circumstances related to their decaying or unsightly appearance on specific building areas (Fig. 3.7). These areas must be identified and, after repair–restoration procedures, also tested to adjust cleaning procedures to achieve surface appearance similar, or at best like the

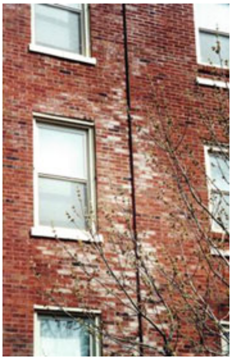


Fig. 3.8 Calcium efflorescence

predominant surfaces on the building treated. This also includes the identification of possible hidden metal and copper anchorage responsible for rust-copper staining events, or masonry blistering within or above the substrate. Rust stains or sheen developing during a cleaning procedure are often the result of an excessive iron content reacting with minerals delivered by blast-water to the substrate. It is imperative to check pH-values and trace metal content of the water supply especially when cleaning a light-colored porous stone and/or architectural features preventing a possible permanent discoloration as it is important to confirm the effective neutralization of all surfaces by rinse water with pH 6.6–7 paper (run-off). Also, besides controlling water runoff on façades, one must control wind swept acidic–alkaline misting to vulnerable and sensitive metal–aluminum frames, glass, various architectural components such as marble and limestone surfaces, wooden structures, cars, neighboring facilities and foliage within the work area. These applications and technical controls will often vary or be fluid according to weather and seasonal circumstances.

In the course of unintentional chemical misting and favorable circumstances a prior incomplete chemical neutralization endeavor can also produce a mild etching effect on various surfaces. Also excessive evaporation and absorption of chemicals and/or blast-water refuse must be addressed immediately and monitored to avoid contamination and future surface soiling brought on by water hydraulics and evaporating contaminants (Fig. 3.8) to the masonry surface (aggravated by unknown chemicals, mineral efflorescence such as soluble salts, etc.)

Conservation and restoring structures is of a specific nature where specialization justifies the addition of equipment for application processes such as for instance brick reversal or turning outside damaged surfaces to inner wall (Fig. 3.9), which includes the utilization of brick–block–concrete cutting equipment, abrasive blast applications and water-filtration–recycling equipment.

Contractors involved must research structures diligently to general establish the following to parameters; tensile strength of brick and masonry (Figs. 3.10, 3.11) surfaces depth of ¼″, this always varies substantially (friability) between job assignments due to environmental impact and past brick firing processes, which

Fig. 3.9 Brick inside out option

Fig. 3.10 Cementitious stucco

Fig. 3.11 Stucco after cleaning

Fig. 3.12 Pressure-washing procedure on swing-stage

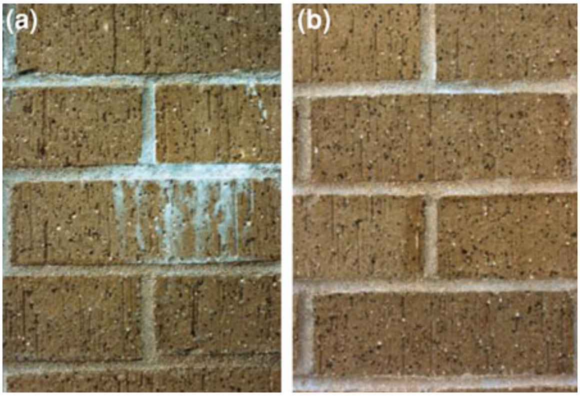


Fig. 3.13 **a** Efflorescence, **b** removed

are today much higher, leaving a historic brick (Fig. 3.12) highly susceptible to wrongful cleaning applications and chemical influences to their softer porous inner core (muriatic–hydrochloric acid); mortar grout strength to the depth of ½″, considering all general and hard to reach) or obvious specific problem areas.

Establish necessary fan nozzle coverage (15° to 65°) for problematic surfaces such as cornices and eaves, and/or test satisfactory pressure-water volume ranges for turbo nozzles and hand operated recycling-vacuum supported spin-jets to guarantee a gentle surface wash down while preventing ghosting, streaking, surface modulation or grout damage. Turbo nozzles must be managed with respect. This type of nozzle rotates with ultra-high rpm a angulated straight hard-hitting jet, producing not only cleaning but also a pulsating jet impact to the surface and can be especially damaging to low tensile strength masonry composites, wood, friable brick, sandstone and/or terra-cotta. This damage may occur starting at 1,000 psi plus to 2.5 gpm plus.

Often the source of staining is an unknown. After removal of all surface contamination with a 15° to 65° fan nozzle design, the appearance of metallic stains may require a chemical reduction treatment which dissolves the metallic salts when rinsed away. Removing these reddish-brown stains (rust) probably of ferrous or ferric origination by embedded iron or steel fixtures located somewhere within the structure being cleaned can be problematic. Before attempting the stain removal application, the source must be identified. Rebar structures and metal fixtures buried within must be laid open to undergo isolation by applying coatings or plastic spray-on systems to all metal surfaces treated by hp-water, water abrasive-blast or UHP method. In this process, the removal of the moisture source to the metals must also be performed preventing future oxidation. Copper and bronze stains often found on roof and ornamental structures mostly identified by green or muddy brown surface discoloration are also caused by oxidation, moisture and/or excessive humidity. If stains are produced while generating a desired patina the source cannot be controlled. This leaves only the adequate surface cleaning and stain removal application combined with a possible clear coat or deep absorbing liquid seal system to the areas in question.

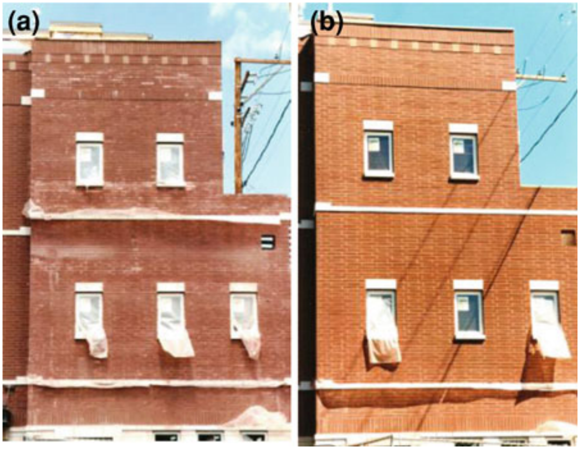


Fig. 3.14 **a** Façade before, **b** façade after

Removing efflorescence (Fig. 3.13a, b) protruding from mortar on bricks, aggregate blocks, concrete walls and/or delaminating acrylic stucco and coatings from masonry surfaces including various stages of mildew development, ivy-vine surface penetration, rust-copper stains and/or heavy smoke stains from fire are all specifically identifiable applications well-suited for the pressure washing specialist. Most of these applications can be performed between 1,000 and 7,000 psi water only, especially when combined with a water pickup and recycling capacity. Although continuous hp hot-water above 212°F can positively shorten removal times of various coatings on masonry surfaces and/or accelerate successful deep-stain removal applications. After a disaster cleanup, remaining fire and smoke stains caused by wood or paper can best be treated with a solution of caustic soda (lye: sodium hydroxide), applied with either abrasive injector, chemical pump, metering equipment or downstream injector and/or by roller. Caustic soda is corrosive requiring adequate safety gear avoiding skin contact and tarpaulin procedures to protect all surroundings and/or sensitive areas from possible wind swept misting.

Cleaning natural stone brick–block and aggregate façades and/or construction cleanup procedures on brick (Fig. 3.14a, b) and stucco walls can by considered the most simplest application requirement within this commercial or industrial facet but require attention in that soiled new surfaces can not be adulterated within the cleaning process. Nor can possible water damage occur to new products like window seals, glass, aluminum, wood and drywall. Many brick cleaners contain a small percentage of fluoride necessary to clean silicon oxide found in brick, granite and masonry surfaces. Precautions must be undertaken before a cleaning procedure by high-pressure water is initiated, since the possibility of etching glass and/or sensitive surfaces exists (particularly soft plate). It is recommended that glass windows, doors and anodized aluminum frames be masked with polyethylene sheeting. Sandstone, Brick, and granite cleaners should not be sprayed on windy days as they could be deposited on unmasked surfaces.

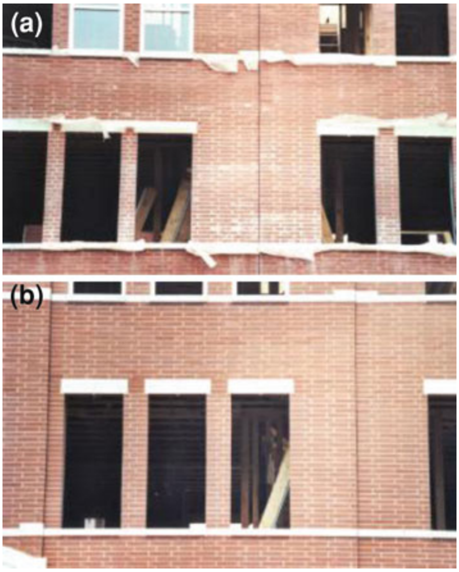


Fig. 3.15 **a** Brick before, **b** after

Fig. 3.16 Brick cleaning before casement installation

When performing services on high-rise buildings, brick and masonry cleaning methods (Fig. 3.15) remain mostly equivalent to the application criteria developed for commercial buildings (two to eight floors, Fig. 3.16). Generally, brick surfaces are cleaned from top to bottom and versus chemical cleaning procedures which most often start sectionalized from the bottom up. This is to avoid a chemical attack on unclean surfaces which can result in permanent etching and discoloration of underlying surfaces. The practical application approach and variety of high-pressure water cleaning techniques is sometimes combined with a desired chemical cleaning process which varies drastically according to the range of building designs, their height, vehicle and pedestrian traffic, erection and obstruction by sidewalk canopies, seasonal weather-temperature, protection of

Fig. 3.17 **a** Brick before, **b** after

surrounding foliage and environmental concerns regarding possible hazardous discharge to sewer systems, etc. Specific application directives are straightforwardly obtained by correctly evaluating the practical access and unobstructed tool utilization to surfaces in question. This includes the vertical–horizontal manual maneuver of spin-jet equipment supported by vacuum refuse equipment, generally exploited utilizing the existing scaffolding (pipe) in use by other trades. The lightweight, vertical 4″ to 5″ industrial vacuum hose assembly, tied to scaffolding in isolated hundred feet increments secured every 25 ft with tie-downs, is sufficient to deliver low volume water refuse to the filtration–recycling unit advantageously situated on the bottom of any building. Swing stage platforms in size of 8–50 ft as well as operations from boom or man lifts on building surfaces less than eight stories high are alternative access solutions. The ability to employ various masking methods (Fig. 3.17) to sensitive structural components with plastic sheeting, tape or liquid strippable masking products for windows and window frames, are some of the obvious identifying job criteria which furthermore permit the application of high-pressure water cleaning techniques on buildings overall surfaces.

True is, that the introduction of high-pressure water applications has substantially abridged chemical cleaning methods by providing environmentally correct and superior time-saving cleaning solutions. It is untrue that high-pressure jets drive chemical solutions into a masonry substrate regardless of prior wetting with clean water to avoid excessive and uneven chemical absorption into a masonry substrate. This is not to say, that on ultra sensitive, damaged or decayed surfaces a two-step chemical cleaning process before or during pressure washing operations would not be beneficial to some specific job assignments (deep-set stains, surface crust-deposits). A correct chemical application is designed to neutralize itself within the reaction process, but its success also depends on a thorough rinse procedure. Acid with a 1.5 pH, applied to surfaces in question and upon satisfactory dwell time treated with a 12.5 pH alkali further emulsifying contaminants suppose to render the chemical runoff to a pH 7 solution. Chemicals are best

applied by a separate low pressure pump facilitating ease of application, fluid volume control, unnecessary misting and a controlled dwell time procedure. This also means starting the rinse application from bottom up and then down ensuring that the runoff water and surface–substrate produce a neutral pH 7. Avoiding the two-step chemical cleaning method in a surface restoration procedure, pressure washing techniques can be enhanced today by utilizing organic chemicals (acids) designed with a buffer component, neutralizing the acid within the emulsifying process of identifiable stains and surface contaminants. These types of restoration chemical are also best applied by a designated secondary pump and can mitigate the brick saturation process with water. Rinsing all surfaces with pressures ranging from 500 to 3,000 psi, applying cold-water will neutralize surface–substrate and run-off water to a pH of 7.

Operational variables such as chemical strength, volume, evaporation and saturation or the important chemical dwell time differ drastically within ambient temperatures encountered on a jobsite. The blanket statements that historic brick buildings are highly susceptible to damage from muriatic acid (hydrochloric) can be considered quite outdated since the application of raw undiluted acid does not exist within a restoration chemistry. Hydrofluoric (acid) restoration chemistry holds a far greater potential for damage to surfaces and substrates (if not precisely administered) than correctly diluted hydrochloric acid.

The decision to apply either the scraping method versus high-pressure-water to remove mortar residue on new brick surfaces is only undertaken due to varying adhesion and mortars' possible chemical surface interaction, which may result in visual ghosting situations due to the permanent damage or etching–softening–discoloration by mortars saturation and dwell time. After the scraping procedure, the use of acid is often unknowingly–knowingly applied to achieve a visual blending effect between disturbed and undisturbed surface appearances. New brick can be very hard on its exterior and will without doubt tolerate the direct removal of most construction residual within a construction site cleanup procedure. In this case, the weakest and most sensitive areas are utilized to identify the important psi–gpm baseline configuration which can vary drastically between various tool configurations (nozzles). Most likely determined and adjusted to concrete–grout surface strength and brick edge–corner tensile strength, avoiding all possible scenarios of high-pressure water damage determines this gpm–psi configuration which must then also permit the total removal of all mortar spatter and various construction residuals.

On new construction sites, indifferent pressure-washing operations responsible for the removal of excess mortar, efflorescence and general construction contaminants sometimes bear the blame for bricks' excessive whitening, metallic and/or brownish staining. Most often this occurs when a specified proprietary chemical and its intended accredited cleaning procedure by a site architect and/or brick manufacturer is inaccurately applied. Under these circumstances the liability of a pressure-washing contractor is immediately thought of or at best made suspect to the appearing visual faults. This inquiry will point to possibly none or inadequate surface wetting procedures, excessive atmospheric cycling, humidity–heat,

Fig. 3.18 Brick staining

excessive chemical dwell time, and/or inadequate rinsing-neutralization procedures or the commencing of pressure-washing applications before the curing of concrete–masonry–grout is complete (30 days plus if at all possible). It is always of benefit to a pressure washing contractor to be aware of an applied grout–mortar product, which varies dramatically between brick and stone installation requirements. The mix proportions can sometimes be analyzed or revised to resist a possible leaching scenario from its color, lime or Portland-cement constituents. Architects and construction site managers should not forget that the culprit may also be the metallic elements in clay responsible for creating various visual effects. These metals being soluble by acid may also result in the spread of tarnish-staining across brick surfaces more often visually stronger on brick face top and bottom joints. Neutralizing the acid with an alkaline liquid–hydroxide solution is successful, but it will not remove the created stains. Rather, in the drying-evaporation process it develops a salty white residue across a brick surface, which is removed with pH neutral high-pressure-water, after a chemical is applied to re-dissolve the existing metallic stains. Excessive metallic activity on various brick surfaces can also originate from incompatible mortar–masonry applications, unprotected brick transportation and unidentifiable storage environments subject to various harmful environmental conditions. Brick staining on new construction is most often reversible but best avoided first of all (Fig. 3.18). The preeminent protection guarding against the unknown is education and research prior or alongside a jobs procurement procedure. This starts with identifying the brick and its manufacturer to possibly retrieve their cleaning recommendations, which most always recommends not using any type of acid. Nevertheless, when researching their product recommendations, most often their label and MSDS information will refer to some sort of acid (probably thinned-buffered). As a result leaving the unsuspecting speechless reminding us that the specialist is always the pressure-washing contractor. Also, regardless of cleaning techniques applied the contractor must avoid all technical application circumstances which can be made responsible for inconsistent surface appearances and ghosting possibilities. One will at a distance first survey all surfaces in question to identify any adhering organic debris, mortar smears, paint-coating spatter, adhesive contamination, cement dust accumulations and specific concentrations of concrete–grout construction spatter.

These mortar concentrations are more likely noticeable in the spatter area of the masons' scaffold-plank board which during the building process moves

horizontally upward in 4–6 ft increments. A scrape crew must systematically remove all spatter; protruding mortar smears and, in short, all materials which may seal a brick surface possibly promoting an uneven absorption–adsorption rate and/or fan-jets surface dispersion other than the rest of the unimpeded brick fascia. The crew will mainly utilize wooden spatulas–paddles–scrapers and hard organic–plastic brushes, removing all surface contaminants as uniformly as possible, including the areas of soffit, eaves, gables and possible exterior insulation and finishing systems which often require their own specific cleaning procedures. Again, stepping away from the cleaned–scraped surfaces will help to more effectively identify irregular uneven surface appearances before the actual wash-down commences. Also this cleaning process should include scaffold boards prohibiting repetitive spatter during the final rinse process.

It is important to pre-wet or better saturate all brick surfaces equally avoiding a disproportionate sponge like chemical absorption. This also insures that the applied chemical remains on the brick surface to be cleaned negating discoloration by bricks soluble trace elements and/or excessive chemical absorption (squander). The best chemical reaction results are achieved when the product contains a strong surfactant permitting the chemical to adhere to surfaces for an extended dwell time by controlling its runoff. Surface damage and discoloration are the result when permitting solutions to dry. Particularly on hot days, dwell times should not exceed 2 min. Pressure-washing brick surfaces in increments from the bottom up, applying a 25° to 65° fan nozzles with an approximately 2′ ft stand off distance to surfaces utilizing 2.5–5 gpm per wand at pressures adjusted to the necessary stain removal threshold at the recommended stand off distances will permit a very speedy and gentle job conclusion. Stain removal and brick cleaning operations are concluded when buildings top row is reached and the rinse cycle with pH neutral fresh water begins from top down utilizing an appropriate nozzle standoff distance. Also the controlled sectionalized rinse off cycle now includes all surfaces from eaves, cornices, window frames, etc., and requires periodic testing of surface and its runoff water to its neutral pH 6.6–7 balance (paper).

After verifying the sufficient and important surface–substrate drying time and result by considering also the possible entrapment of water vapor in specific or prone areas within the substrate structure, concrete–masonry, terra-cotta and brick surfaces are treated with either breathable barrier and/or breathable water repellent deep penetrating clear (Fig. 3.19) or pigmented non-film forming coatings. According to exterior exposure, climate and architectural desires, applied coatings are solvent or waterborne and can be applied, by airless paint applicator systems and/or water injector method.

Cleaning procedures on high-rise buildings require sometimes extensive high-pressure hose assemblies. Identifying the psi losses within a high-pressure hose assembly recognized as pressure drop or friction loss can simply be done by removing the nozzle from its gun barrel retainer and actively operating the hp-gun, avoiding nozzle restriction. The necessary psi-energy is correctly identified by equipment pressure gauge when the direct displacement pumps max operating rpm is maintained. A pressure gauge with a sufficient incremental readout incorporating

Fig. 3.19 Brick before and after sealing

Fig. 3.20 Limestone before–after

a male/female quick-coupler armature attached between a pump heads discharge fitting and the first hose assembly is an alternative evaluation procedure identifying the psi requirement when pushing a water column throughout an open hose-tool assembly. Adding the indicated psi necessity to the equipments standard max operating pressure will permit the evaluation for added horse power input pre-requisites. Piston–plunger pumps by force deliver high-pressure water equally throughout any system. The only question is the horsepower essentials, identifiable by an engine and pump overload scenario when internal friction becomes excessive. This technique is most practical for all pressure drop evaluations concerning a hose-tool assembly, since it includes the hp-hose length and restricting hose fittings, friction losses by internal gun or tool designs and distant job locations, and is inherently far more precise than a mathematical explanation often presented by various application enthusiasts. It will not identify nozzle design efficiency or required standoff distances to surfaces cleaned.

Before a cleaning solution by high-pressure water for natural stone and its substrate in question can be offered the requirement exists to correctly identify the stone's architectural intended purpose and possible origination. Marble, granite, limestone (Fig. 3.20) or slate in their widely varying commercial applications, such as interior and exterior wall cladding, interior or exterior paving, curbing, pool and

Fig. 3.21 Chemical application

Fig. 3.22 Cleaning and rinse cycle

statuary applications must be correctly identified as to their original architectural surface structure and present soiling and/or aggressive surface contaminants.

Siliceous stones–rock are quartz based stones such as granite, serpentine, slate and soap stone, and, under normal conditions are easy to clean. Calcareous stones are travertine, onyx, marble and limestone which are susceptible to liquid—chemical detergents at levels other than pH 6.6–7. Therefore, high-pressure water cleaning and rinsing of these stones is the preferred cleaning method.

Stains in stones are likely of organic and metallic materials or of an oil–grease saturation nature. Most deep-set organic stains will require an oxidizing agent such as peroxide or commercial–household chlorine bleach in various solution ratios to water. Again, deep-set stain removal processes on marble and limestone substrate are similar and often only vary in the chemical being applied (non-acidic).

Limestone–marble contain calcium carbonate and are very sensitive to chemicals, especially to acidic cleaners. Chemical application specifications (Fig. 3.21) are established only following high-pressure water removal of all surface contaminants and upon a dry and/or wet substrate ensuring that any products used are specifically formulated for the limestone and marble deep-set stain removal application (ph-neutral non-ionic detergent, light bleach or ammonia water solution). At the completion of the cleaning process the stone is properly rinsed (Fig. 3.22) and left free of any residual alkalinity or acidity. Limestone and marble can be pre-cleaned using high-pressure water at 500–3,000 psi with a 25° to 65° fan nozzle at 2.5–5 gpm. After the adequate drying, stone cleaning applications are often finished by applying water repellent, penetrating but air permeable sealer.

Fig. 3.23 Dry and stabilized art deco

Cleaning outdoor pool, hot tub and patio areas (moss and algae), with pressures from 2 to 5,000 psi up to 5 gpm hot or cold water utilizing a turbo nozzle or fan-jet assembly can be supported by suppressing future growth in applying a mild household bleach treatment after the moss, fungus and algae are removed.

At times, where a stone is blackened it may be necessary to pre-clean with an alkaline product starting from the bottom of the building or structure working upward. The product can be applied by brush, spray applicator, roller or pressure-washing gun, moving from natural break to natural break. Following a 3-min dwell time, the alkaline solution can be rinsed using the above mentioned pump performances. It is recommended that a mild acidized cleaner be utilized after the alkaline cleaner has been thoroughly rinsed. This acidized cleaner and subsequent rinsing will remove any inorganic residual contaminants and ensures that remaining alkalinity is neutralized. Under certain conditions, such as extreme friability of a monument (Fig. 3.23) stone surface as often found in cemeteries, rinse pressure can be reduced to equal a kind of rubbing–brush–bristle stroke category. Also excessively weakened, decaying brick or porous configuration specifically stone can be treated with an stone strengthening and water repellent air permeable solution, which when absorbed does not equal a coating rather will slowly cure within the stone structure providing enhanced physical stability when dried. Lightly soiled limestone seldom requires the alkaline pre-cleaning process. Remember, limestone and marble substrates are semi-self-cleaning stones and are most often best maintained by high-pressure water cleaning operations with varying pressure and water volume adjusted to surfaces encountered requiring no further chemical treatment.

Many areas of a building are never exposed to water. Nonetheless, over a period of years, encrusted black substances, chemically identified as calcium sulfate, will form under eaves, cornices and belt courses. Unfortunately, the few chemical cleaners that attack these encrusted areas also attack the surrounding calcium carbonate. Therefore again high-pressure water equipment can be applied to

Fig. 3.24 Pores limestone, clean and dry

Fig. 3.25 Soiled limestone

dissolve the calcium sulfate by a prolonged and repetitive soaking with plain water (atomized). Final removal is achieved by applying a pressure-washing gun at 500–3,000 psi at 2.5–5 gpm with fan nozzles at 25° to 65°. Prior to commencing a soaking operation, a building must be inspected for areas most susceptible to inner water seepage. All areas where water could penetrate are caulked and covered by plastic. City or well water should be tested to determine their mineral content and pH value. Cascading water with a high mineral content may cause stone to discolor. In-line water treatment and filters are available to remove excessive amounts of minerals. Water utilized for cleaning should always have a neutral pH value of 6.6–7. Excess acidity or alkalinity will also affect the minerals in the stone and can later be possibly responsible for surface discoloration appearing at some stage within the water evaporation and surface drying time-frame. The use of nonferrous tooling is recommended within this type of cleaning–restoration application. The position of nozzle carriers will guarantee even coverage over all calcium sulfate areas and, if the timeframe demands, securely fastened to scaffolding. The prior wetting, soaking, intermittent jetting or continuous mist (atomized) spraying process always commences at the top of a structure. Never forget, that in soaking operations, foundations must be protected to prevent leakage into basement areas. Also masonry cleaning can be quite seasonal. Porous substrate (Fig. 3.24) is vulnerable to freezing and thawing (cycling) as is the repair or repointing procedure of mortar joints which commonly will not commence with temperatures below 40°F and above 90°F. More often than not are the aggressive air pollutants (Fig. 3.25) not the only contributors to surface soiling and structural deterioration

on restoration and/or preservation sites demanding a variety of trades working alongside in harmony. Treatment of contaminants such as iron oxides (rust), copper stains, urea, or removal of coating–paint and sealants are identified by historical architects as they also identify the method of removal and utilization of specific chemicals and their application. Historical commissions providing a funding grant may maintain a direct review involvement to guarantee projects scope, which includes verifying the performance criteria by all trades involved within a restoration procedure. Architects employed by a historical commission will work closely with construction site architects to guarantee strict adherence to agreed plans and specifications identified at the pre-bid conference, combined with contractors insurance-bonding and can do qualification statements, guaranteeing work methods and results. Generally the project philosophy to clean a historic masonry, brick, marble or limestone structure is to remove and/or neutralize the visually changing and possibly destructive contaminants such as carbon-soot, acidity, algae, fungus, molds, paint and coatings, etc. while not damaging or altering any of the original masonry design, stone tooling details, texture and adjacent joint's grout surface integrity. The contractor should always exact precise application procedures determined by architects as to the practical validity, and desired tool applications. This includes reviewing carefully the chemical manufacturer's literature, or best, consult with a representative as to their opinions and product warranties. Application variations must always be discussed in the mandatory pre-bid conference to their validity avoiding discrepancies brought to the architects' attention after work has begun. Often an opinion may develop during the inspection of an existing condition on a historic building site which may speak to or dispute one or various proposed application techniques. This can include a hidden performance problematic when working in unison with other trades.

The scope of work and specifications for masonry cleaning and historical brick restoration may include, besides cleaning and a sealing performance, a limited mortar joint repair–installation and/or replacement of pigeon control systems, etc. Added trade involvements require attention.

Specifications will be identified such as masonry restoration and cleaning; and under the division; special conditions; required miscellaneous services which call for reasonable customary conformity inherent to restoration requirements involving all trades including that of a pressure-washing contractor. Coordination of work with other trades, and the continuous protection of the portion of work performed during a cleaning and restoration procedure must therefore always be addressed and can result in a fluid, quite varying application criteria. The pressure washing contractor must also be careful to address the final construction site cleanup. Various trades produce various waste materials, stains and possible surface contamination. In addition to his operational cleanup provisions he can consider and possibly include his required time and expertise to wash and polish glass inside out, remove foreign matter, marks, stains, foreign paint, caulking, fingerprints, soil and dirt from painted and/or decorated stained work, or on hardware fixtures and equipment surfaces found on exterior or in interior areas. This cleanup provisions are very important and can be quite substantial demanding

Fig. 3.26 **a** CMU block before, **b** CMU block coating removal, **c** CMU block after

time and equipment necessities best identified within the contracts general conditions.

New or old buildings regardless of stone or masonry structure are most often designed to consider basic airflow–heat loss and water vapor migration through the buildings envelope, consequently protecting structural components as well as guarding against damage produced by mildew and/or mold growth. The contractor is well advised to study typical insulation, vapor and air barrier designs including façades brick–stone iron (beams) straps, anchors and/or wall retainer systems and their possible locations. Often when deviating from an original building design, the subsequent changes to the air to air transmission coefficient resulting from restoration procedures and/or erection of structural additions, obscures or mistakenly encloses critical areas. This can perhaps produce an unforeseen mitigating path for mildew–mold development as it may also divert water or vapor penetration to unexpected building areas. There are distinct differences between vapor and air barrier systems which vary regionally in their design criteria. Various flashings, cavity flashings and present weep-holes, their locations including drainage configurations for buildings inner to outer envelope which include the identification of interior to exterior gravity drainage locations into the public main sewer installation are all factors to be considered in a well developed job description. Information on air–vapor barrier design technology can further be researched on the Internet, http://www.airbarrrier.org

When the need arises to clean concrete masonry units which are smooth or split-faced (CMU) block walls (Fig. 3.26) high-pressure water is always superior to any other cleaning method including the application of all chemical techniques. Most often these structures require services not due to weathering or general soiling but more often due to the removal necessities of graffiti-tagging, surface preparation for coating or masonry work and/or an existing coating–paint delaminating problem. The latter, most likely due to substandard adhesion created by environments within the block wall cavity, responsible for producing an elevated moisture vapor transmission through the wall. Chronic increases in moisture vapor pressure carrying calcium salts to the outside surface of the wall forming a visually visible efflorescence is typically accompanied by coating cracking and peeling along block joints and block surfaces which include accelerated coating damage on the building side more susceptible to thermal cycling (south side versus north side). The nature of concrete block's porous surfaces is ideal for the utilization of a

Turbo nozzle operated between 2,500 and 5,000 psi at 2.5–5 gpm hot and/or cold water. Turbo nozzles inherent variable angle intensity permit the cleaning and removal of coatings in deep crevices, concrete voids and pores and will always outperform the abrasive blast technique. Manually operated, vacuum supported spin Jets are also ideal due to the added potential of refuse separation, water filtration and recycling capacity. When aged and deteriorated coatings are to be removed, the reasoning might not only be to provide a sound substrate for a new coating application. Aesthetic reasons can be the motivator to leave a substrate uncoated and exposed or else an existing coating contains hazardous materials as lead and heavy metals preventing remodeling or demolition procedures and/or sometimes existing coatings are damaging to a substrate by limiting adequate moisture release (non-breathable) accelerating structural decay.

The selection of required tooling and job essentials depend on the condition of the substrate, the type of coating encountered, adhesion to and penetration into the substrate, number of paint layers and elasticity–tensile strength factors. In general, applying high-pressure hot-water above 200°F utilizing a 15° to 25° fan jet or Turbo nozzle is the preferred tool combination effectively outperforming cold-water combinations at 3–7,000 psi. If it is found to be lead paint, which is becoming one of the most recognized generally hazardous materials one will find, that a comparatively low-cost coating removal application is disproportionately obscured by necessary product-refuse handling and deletion costs due to enforced local and federal lead abatement–disposal regulations. There are several methods to determine whether paint contains a toxic level of lead. Savvy contractors will always carry a household swab test kit to possibly justify a further refined test procedure. Testing can be done with a portable X-ray fluorescent analyzer or a sodium sulfite solution. The most reliable testing is achieved by utilizing an atomic absorption spectrophotometer. Samples of paint are analyzed by state-commissioned laboratories. Separating refuse from blast-water and recycling the blast-water through a phosphoric filter assembly permits a concentration and volume reduction of the lead (heavy metals) containing refuse. Contaminated paint forces contractors to identify, contain and package the compressed refuse according to the law before a transport to a hazardous waste incineration or deposit site is possible. For exterior lead abatement, the high-pressure, low-volume water removal method sometimes combined with a periodic chemical initiation process offers several advantages over expensive snail's pace chemical removal operations. Lead-free paint can be removed without the involvement of a hazardous material handling regulation in particular when water recycling and refuse filtration–separation equipment is utilized. Nevertheless the accumulation of a refuse volume must be understood as to its potency and possible health risk.

Although graffiti removal is included in the coating removal chapter, it is impossible to determine an adequate cleaning procedure without on-site testing, for the artist vents his creativity on the most unimaginable surfaces. Difficulties arise due to the virtually unknown paint medium, often a solvent based product penetrating into substrates porous surfaces or various coloring products adhering to a vast variety of painted surfaces, which must first be tested as to its structure and

GEAR - LIST AUTHORIZATION

Brick - stone - stucco - masonry cleaning, structuring, restoration

Customer & Company: Web site: e-mail:	 Fig. 3.27 abrasive-blast equipment	Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:

Job Description:

Job Location: Job Site Risk Assessment: Specify:

Job Review Performed by:

Base structure:

Granite:	Marble:	Sandstone:	Limestone:
CMU block w.	Exposed aggregate:	Sand surfaced brick:	Stucco-synthetic:
Slate:	Exposed concrete slab:	Concrete:	Steel-iron:
Brick pavers:	Travertine:	Brick:	Other:

Scale - stain - coating - paint type :

Efflorescence:	Graffiti:	Urea, organic-growth:	Mildew:
Lead paint:	Mortar:	Iron oxide (rust-copper):	Fungus-mold:
Epoxies:	Oxidation:	Grease-oil:	Other:

Lead: Toxic contamination:		Test:	X-Ray fluorescent analyzer:		Sodium sulfite solution:

Environment: Industrial: Commercial: Residential:

Existing structural damages:			Explanation:

Patch testing:

Methods:	Chemicals:	Products:		
	Cold high-pressure water:	psi:	gpm:	Nozzles:
	Hot high-pressure water ºF:?	psi:	gpm:	Nozzles:
	Water abrasive blasting:	psi:	gpm:	Nozzles:
	Steam cleaning:	Temp:	gpm:	psi:

Total sq footage below 10 ft.: (ground up)
Total sq footage above 10 ft.: (platform?)

Scaffolding:			Boom lift: (bucket)		Tarpaulin procedures:		Traffic-pedestrian control:
Structural circumstances: Vegetation: Steel-copper fixtures: Drains, drainage:					Aluminum fixtures: Overhead power-lines: Vehicle traffic-pedestrian:		Other:

Describe application and work procedure:
Wand extensions, water filtration recycling, vacuum supported spin-jets, turbo nozzles, etc.:

Itemize equipment: safety gear, expendables, labor time, equipment times, etc.

possible friability. There are some surfaces which permit the utilization of a crystalline (Fig. 3.27), inert, odorless and water soluble abrasive product, calcium carbonate powder (baking soda) or a minuscule amount of Portland cement powder and possibly nutshell grain products providing a buffing, slightly abrasive surface treatment when combined with high-pressure water (abrasive injector).

The chemical industry provides many useful cleaning solvents. Applied are only the ones which provide maximum paint removal capability while discouraging ghosting (the faint outline of graffiti in pores). Should ghosting appear the aforementioned cleaning techniques are effective.

Used brick suppliers may view the hydro-blast method as the most innovative cleaning procedure available today. Bricks are laid in tight formation and blasted between 2,000 and 7,000 psi at 2.5 to 5 gpm with a 20° to 65° fan or turbo nozzle. Tight brick formation is essential to the preservation of edges. The industry has developed a variety of tools that apply high-pressure water at lower volumes, achieving a much higher square footage performance rate than previously possible with spray bars. The industry refers to these units as whirl disc, rotary jet carrier, spin-jets, rotating ramp carrier, surface jet mill and turbo nozzles. Their designs are intended to be mobile or in a hand-held configuration either air, hydraulic or self-propelled. Some will feature a vacuum capability combined with a refuse collection, and water-recycling filtration unit. Such state-of-the-art tools are vital to any successful surface cleaning process and often will totally eliminate the need for chemicals.

Brick restructuring or antiquing is achieved by conventional water abrasive-blast methods. Brick glazing is removed by exposing porous, sometimes, colorful, uneven structures. The coarseness of the blast medium applied at pressures ranging from 3,000 to 7,000 psi is the determining factor for the final surface structure.

For brick hardness, surface strength and information on composition; Information on the Internet; Water proofing-repellent, non-film forming silicone and epoxy compositions for concrete, exterior brick, stone and masonry surfaces.

The Brick Industry Association, http://www.gobrick.com, EIFS-synthetic stucco, http://www.exterior-design-inst.com, The Stucco Manufacturers Association, http://www.stuccomfgassoc.com, The Portland Cement Association, http://www.cement.org, National Concrete Masonry Association, http://www.ncma.org

3.2 Surface Pasting, Airborne Dust Suppression, Liquid Non-film Forming Seal Applications, Biosecurity, Sanitizing, Decontamination, Foaming–Soaps–Detergents–Acids

Cleaning and/or restoration complexities or lack of necessary psi–gpm performances may require a chemical metering process supporting pressure-washing or water-jetting endeavors. Furthermore, there are various mitigating factors justifying the tool expenditure and subsequent specialization in application technology. Injector proficiency can support a coating and paint removal task, deodorizing and/or solid odor counteracting technique and the application of breathable liquid penetrating sealers to concrete–masonry–brick–block and wood surfaces. In the transportation and agricultural environment chemical injectors and foam generating equipment may be of importance to apply insecticides and herbicides, alkaline and/or acids to various surfaces. Commercial and industrial environments may be in need of bulk oil–grease and/or deep set stain removal applications of the

same, or the utilization of flash rust-corrosion inhibitors, phosphatizing iron-steel surfaces to enhance paint bonding criteria and/or providing biosecurity-sanitation as well as fungus-mold inhibitors. Incorporating the equipment for polymer jetting procedures or various decontamination practices in commercial, industrial and nuclear industries (power plants) requires extensive technical and fluid-dynamic knowledge facilitating the correct usage of this equipment.

In discovering today's viable pressure-washing and hydro-blast cleaning characteristics, the major chemical manufacturing industries have as yet to set and create adequate practical application guidelines for customers favoring high-pressure water tool technologies. Therefore the application technician must hone his chemical application curriculum by recording all past job experiences and results creating his or her practical information base. In-depth knowledge and characteristics of contractors' equipment and tool performances (gpm–psi) in relevance to a variety of successfully completed application histories which also takes into account all encountered surfaces–substrates, their uniqueness and job specific application circumstances such as chemical dwell times and rinse procedures, weather, temperature and humidity, etc. The first upstream–downstream injectors were utilized by Leonardo da Vinci for delivering paint to his canvases. Today there are five mechanical methods to introduce various liquids to a pressure-washer or hydro-blast water stream. Upstream injectors introduce liquid chemicals to the water suction side of a unit either directly into the water supply hose before the introduction to the float tanks ball or water metering assembly or between the float tank and the pump water intake. Both methods will permit only the additions of liquids negating coagulation, depositing chemical constituents, generate abrasiveness and/or foaming characteristics. Adding a liquid polymer to the blast-water reducing water turbulence created by inferior nozzle designs in focusing its water jet is an example as is the adding of sodium nitrate for flash rust suppression. Also in upstream metering processes, utilizing excessive chemical acidity must be guarded against. Keep a light chemical viscosity to avoid coagulation by insuring proper mixing with water. If the upstream metering method must be used, consider purchasing and installing a metering pump operating at approximately 125–150 psi with flow adjustability from 0 to 1 gpm. These chemical pumps are electrically actuated via a float mechanism, pressure switch, or series flow switch sensitized by the trigger-gun operation. Metering pumps operating at 24–115 V or air-hydraulic driven are readily available. The discharge line of a metering pump may be installed directly into the in-line suction orifice of a hydro or pressure-washing pump.

Recently, most pressure-washing and hydro-blast systems feature a trigger-gun operation allowing the operator to commence water jetting at will. In the off position, an automatic pressure regulator will bypass and return the produced water volume to the suction side of a hydro-blast or pressure-washer unit, either into its water storage tank (float tank), or directly into the pump head suction orifice. This operational method creates a basic problem for most upstream metering functions installed between float tank and pump head. The necessary vacuum is created by a pressure reduction in the water supply line restricting the

free flow of water to the pump head. A flow restrictor is strategically installed into the suction orifice at the bottom of the water storage or float tank.

The volume of chemicals allowed entering the suction side of a pump head is regulated by a needle valve. Preset, adjustable, or solenoid-operated valves are available with a performance range of ten parts water to one part chemical up to 240 parts water to one part chemical.

The applicable ratio also depends on viscosity and various specific fluid characteristics. A one size fits all chemical application setup does not exist due to technical and application varieties. Contractors wishing to utilize such a chemical injector method must be aware of the following; any water flow restriction to the suction side of a pump is disturbing. It is a known fact that such restrictions enhance cavitational effects. In time, accelerated cavitation will damage pressure regulators, valves, pistons and their packing and include the gear-end when a gaseous-compressible water medium is encountered (pressure-stroke). Dubious also is when the trigger-gun in off position signals to the pressure regulator or pressure relief valve to return chemically-admixed water to the storage or float tank. This facilitates foaming and/or air saturation added to the already chemically admixed by-pass water (internal water velocity). Avoiding further introduction of chemicals to the by-pass water within the closed trigger-gun position, some manufacturers return this by-pass water directly to the suction orifice of the pump head, equalizing the vacuum otherwise maintained between restrictor and pump head suction orifice, thus stopping chemical draw from the chemical valve. Manufacturers in their efforts to prolong pump life discovered that saturated by-pass water returned directly to pump heads suction orifice can cause, besides cavitational damages to valves, pressure regulators and packing, a thermal shock to ceramic plunger sleeves. Evident especially when prolonged jetting intervals occur and jetting operations are continued introducing cold water to excessively heated packing-sleeve surfaces. Due to their elevated rpm configuration piston pumps are not suited to build a vacuum on their suction side, nor are they generally matched to pump viscous chemicals exceeding jetting waters specific weight and friction characteristics. Overall, the upstream chemical metering method is at best limited therefore contractors are destined to compromise. Regardless, gravity feed procedures are more common than one admits, although continuously adding chemicals to the storage or float tank causes eventual damage to equipment. Job variety can result in chemical variety only accelerating such damage possibilities. Downstream injectors (Fig. 3.28) situated on the pressure side beyond the pressure regulator, burner assembly and thermostat on hydro-blast or pressure-washer units have the operational advantage that chemical, detergents and acid contact with equipment internals is avoided. The disadvantage is that most downstream injectors are operational only by reducing the hydraulic pressure within the high-pressure hose. This is performed by adjustment of a dual wand assembly shifting from jetting nozzle to an oversized nozzle reducing systems operating pressure, or by utilizing a variable pressure single wand nozzle affixed to the trigger-gun assembly. Most often an injector adjustment must also be performed with every hp-hose addition compensating for the Hp. Water in added fluid friction-drag and

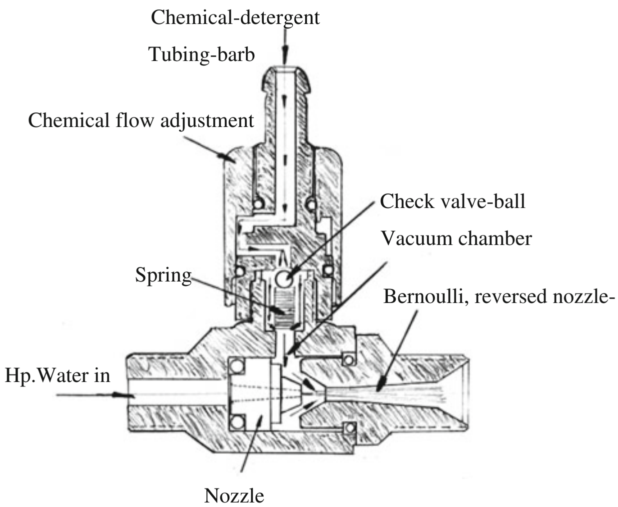


Fig. 3.28 Downstream injector

mass. Depending on the injector's design, Chemical volume control is recognized to be quite inconsistent or at best difficult due to variable chemical viscosity; and chem.-hose length. Injector performance can possibly be rendered altogether inoperable when the hp-hose and gun assembly requires more then 220 psi water transfer pressure impeding the necessary vacuum development of 35% plus reduction of systems operating pressure. Only when recognizing the actual gpm jetting performance is a precise metering function possible. A variable dual or single lance-wand extension permits a low-velocity, low-pressure application for the all important chemical dwell time. Most injectors are adjustable, dispensing one part chemical to four parts water (up to 1 part chemical to 240 parts water). There are operational disadvantages to downstream injectors. Less sophisticated injectors do not dispense chemicals beyond 150 ft of hp-water hose length. Accumulated friction losses and flow restrictions in hp-hose assemblies will not permit the necessary pressure drop of 35% plus actuating the injector. On hot water machines an erratic injector operation can be caused when lowering the waters boiling temperature under reduced pressure. Chemical injectors' functionality will also be compromised when installed in opposition to intended water-jet flow. Injectors are sensitive to chemical caking, fluid impurities and have a marginal acid resistance.

Chemical applications and operation of chemical injectors is best guaranteed by an experienced operator. Excessive hp-hose runs or pressures above 200 psi require an in-line high-pressure chemical inject or (Fig. 3.29), which can be installed to the first or any hp-hose assembly including the last nearest to the jobsite and trigger-gun operator. This psi performance combined with the injectors' precise metering function supports most all application varieties.

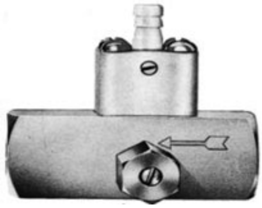


Fig. 3.29 In-line high-pressure chemical injector

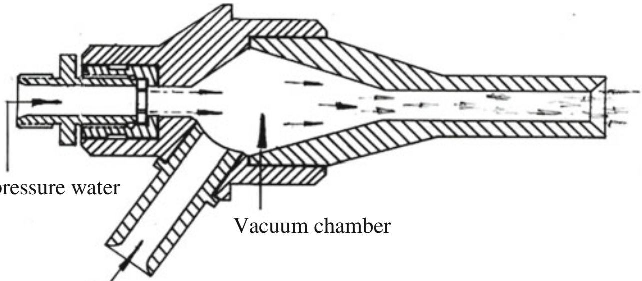


Fig. 3.30 Abrasive injector, pressure-washer

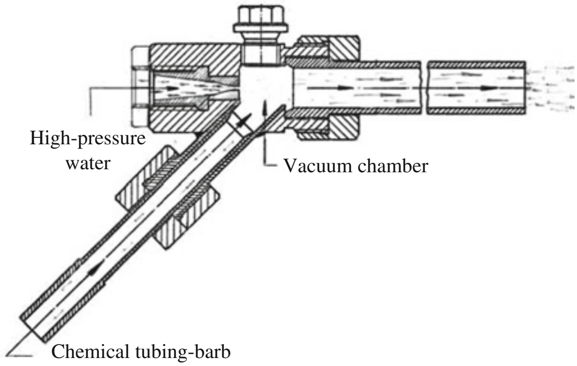
Unnecessary chemical usage and accidental misting is always of great concern. To create and achieve a celled foam matrix to support various dwell-resident times of a desired chemical or detergent upon a surface–substrate the industry developed a foam nozzle technology utilized most often within the food industry, or for biosecurity applications in agricultural environments and automated vehicle–truck and/or rail–car wash operations. The various available foam nozzle designs prove quite insufficient within the pressure-washing and hydro-blast application palette. Pressure-washing and hydro-blast applications in commercial and industrial environments often require a far greater nozzle standoff distance to surfaces facilitating a quick and practical chemical application not achievable with dual wand or foam nozzle technology.

Converting water abrasive injectors (Fig. 3.30) and concrete cutting heads to chemical injection-foaming devices has proven quite successful in providing a superb nozzle stand off distance. Displacement pumps at their given operating rpm permit a precise chemical metering function.

Due to ultra-high nozzle velocities (Fig. 3.31) within the vacuum chamber, a super tight foam matrix is produced, while misting of surroundings is Chemical tubing-barb dramatically mitigated contributing to a far greater nozzle stand off distance and area coverage otherwise not obtainable (300% plus).

Because of increased chemical resident-dwell times, the ease of visual surface coverage-assessments, the achieved greater nozzle stand off distance between operators and surfaces in question, or the desired advanced product foaming parameter and/or superior water jet rinse impact renders this injector type quite indispensable. Tool or equipment application simplicity can be specific within

Fig. 3.31 Converted cutting head



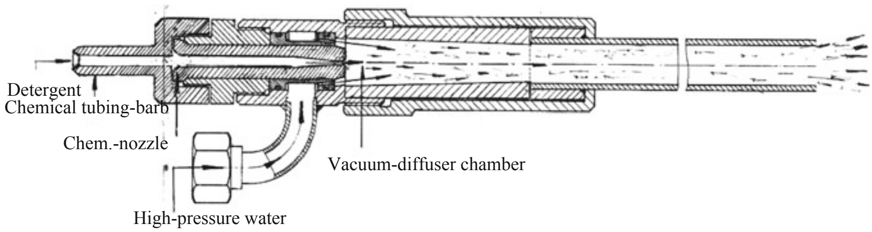


Fig. 3.32 High-capacity injector to 7500 psi

certain industries, as for instance, decontamination in nuclear power plants, where vacuum generating high-pressure water will carry one part chemical which is combined with a chemical introduced on the vacuum or discharge side of an injector.

In contrast to chemical injectors, they create a much higher vacuum and airflow ratio. These commercial and/or industrial water abrasive blast units function more like a jet pump to convey the otherwise necessary abrasive supply. The possible chemical fluid draw can also be 2–8 times higher in fluid volume than the necessary amount of water to operate an abrasive-blast (Fig. 3.32) or concrete cutting as is the vacuum development between 22″ and 31″ of mercury (In HG.).

Controlling the chemical volume is achieved by a simply predetermined and sized chem.-nozzle or in operating a needle valve assembly to adjust the chemical supply by volume or flow. Mix ratio is determined by calculating pressure–washers or hydro-blast units' gpm performance and actual desired chemical volume added per minute or hour. In general, jet-injectors are the extension of a trigger gun wand-barrel assembly isolating chemical contact to the injector assembly. Therefore, material compatibility, acidity, flammability, abrasiveness and viscosity are of secondary concerns. Injectors offering a superior chemical compatibility are readily available.

The inherent advantage of this injector type is that the chemical fluids accelerating into the injector's vacuum-mix chamber greatly diffuse the actual jetting

Fig. 3.33 Gas station area

Fig. 3.34 Waste stream recovery

impact. Injector design permitting, jetting impact can also be manipulated by a steady measured air flow to the chemical suction hose or vacuum chamber.

Exterior–interior area decontamination by sequestering radioactive metallic ions and suspending these particles in a two-step procedure permitting a flushing–pumping–rinsing and wiping application, or cleaning–removing and suppressing mildew and algae contamination by utilizing a sodium-hypochlorite treatment, and for grease or tar deletion by applying caustics such as sodium or potassium hydroxide can be considered the industrial application utilization of this type of injector. Performing flat work (foaming), such as on gas station areas (Fig. 3.33), drive-thru's and in large parking facilities or for dispensing bactericides, disinfectants and sanitizing products in agricultural environments, and/or pasting walls, dust suppression on floors and open gondolas (trucks–trailers, railcars) including performing disaster cleanup procedures and fire restoration applications can be considered the commercial utilization.

When applying high quality, penetrating and high foaming biodegradable chemical concentrates, designed to react with greases, fats, wax and carbonized materials to either dissolve or emulsify them, water–chemical ratio and predetermined dwell times must be precise. Their general mix ratio to water for a light soiled condition is approximate 80:1, a moderate to heavy condition diluted 50:1, and where heavy wax, grease and carbon deposits are present diluted 20:1. It is important to realize that a high-pressure water cleaning application performed with fan jet, turbo nozzles or spin jets will remove 98% of all surface contaminants.

The resulting waste stream (Fig. 3.34) derived from cleaning gas stations, fast food and bank drive-thru surfaces, parking facilities and pedestrian traffic areas,

etc. will most likely result in a hazardous waste stream classification, especially when an emulsifying agent has been applied. This will require the utilization of a mobile water filtration and recycling unit. Controlling and preventing all created discharge to enter adjacent sewer systems or open grounds is imperative. Metals such as cadmium, lead, and copper can interfere with reproductive cycles of fish, invertebrates and other aquatic life, as does turbid water affect the growth of aquatic plants by reducing available sunlight and the smothering of bottom dwelling aquatic organisms. The generating source of pollutants by motor vehicles is transferred, and therefore includes the accumulated refuse discharge from parking lots, gas stations and drive-thru areas. Hydrofluoric, phosphoric and Nitrilotriacetic acid, sodium–potassium hydroxide, are ingredients found in various concrete cleaning products and includes Meta, Para, and Ortho-Xylenes compounds found in various biodegradable concentrates. These trace elements must always be removed from all surfaces within a high-pressure water cleaning application.

Most of today's water repellent silicone based technologies, providing non film forming; deep penetrating product applications (breathable sealers) for stucco–masonry, concrete, brick and stone surfaces are manufactured as either water or solvent borne identities. Preferred for their environmentally correct and safety advantages, water borne products are most often applied utilizing the water injector method due to minimal volatile organic compound emissions (VOC). This application is most often intended to protect and enhance the look of exposed concrete, stucco–masonry, brick and stone surfaces. Solvent borne products are most often applied with manual pump-up sprayer units or paint-coating equipment. In transport to and from a jobsite all solvent and water-born products, including chemicals in liquid or dry form must always be identified and accompanied by a material safety data sheet, utilizing OSHA's hazardous communications standard 29 CFR 1910.1200, recognizing the chemical manufacturer's name, hazardous ingredients-identity, physical and chemical characteristics, fire and explosion hazard data, reactivity data and conditions to avoid, health hazard data, precautions for safe handling and use, which does include product control measures.

When acting in response to operational mishaps or accidental releases, the liquid product jetting and vac-jet recovery is an excellent application technique when dry, viscous or liquid bulk materials–products are returned to their manufacturing process or containment.

Providing this cost effective and measurable product recovery solution by circumventing further contamination of products in question is quite alluring to maintenance personnel as is the equipment utilization when flammable or volatile substances are present and they must be removed or transferred. Final cleanup endeavors after a bulk removal on remaining surfaces are also most often subject to decontamination and/or sanitation procedures by any one of these five chemical injector methods.

Equipment effectiveness relates directly to pump horsepower-input, requiring a minimum of 20 horsepower to enter this application field. General commercial and industrial product transfer applications demand a 45–150 hp plus jet-pump drive.

The removal of contaminants, corrosion and condensation and/or water entrapped within a hydraulic-oil or lube-oil system is a variance of this application curriculum. When an appropriate scale removal and corrosion neutralizing application is performed utilizing possibly pre-heated turbine light oils or applying heating oils, diesel fuel and liquid chemicals, which include jetting with soda-ash brine or if slurry-emulsifying techniques are applied, fluid knowledge and fluids structural behavior patterns expressed in abrasiveness, viscosity, specific weight, flammability, compressibility, foam-ability and acidity must be fully understood. When using liquids other than water, extreme caution must be taken to protect the pressure-washer and hydro-blast unit's gear-ends. Fluid handling should best be supervised by a chemical fluid engineer.

The fluid-end (pump head), packing, o-rings, hoses and trigger-guns must be compatible with desired blast media. Piston pumps, the heart of a pressure-washer or hydro-blast unit, utilize high-grade materials resistant to most common fluids within this application. Incompatibility of packing structures will result in brittle or softening of packing materials. This should not create a problem as compatible packing is available through packing or equipment manufacturers. Products passing through the packing structure (packing glands) are best collected in buckets or returned to unit's suction tank via a small portable air, hydraulic or electrically-driven pump. Electrically-driven pumps can be used only in the absence of volatility and fire or explosion hazards. First and always disconnect the ignition system by removing the power cable or belt drive from the generator when pumping flammable products through a pressure-washer and its hot water burner assembly. Due to ignition source and heat generation, gas engine pump-drives are incompatible with most applications. Flammability and compressibility (psi) must always be a known parameter. Anything above the specific weight and viscosity of water will force a reduction in pump-engine rpm. Most applications do not require more than 1,800 psi operating pressures. The rpm reduction will keep velocity and valve timing under control. At all times, the operation must be within the frame of the gear-end and motor's rpm-horsepower performance curve specified by its manufacturer. A secondary pressure regulation and fluid oriented adjustable safety valve combination must also be included with most every application encountered.

Polymer jetting methods are regarded by most operators as mystical. Mechanically-charged polymer water reduces the ongoing cavitational process by providing a fluid drag reduction to valve and pressure regulator surfaces, pistons, ceramic sleeves, packing and nozzles. Scientists have developed liquid additives capable of reducing up to 50% of the liquid drag found in these high velocity areas. This is especially noticeable in units operating above 3,000 psi. Operators recognizing a dramatic improvement in nozzle standoff distance especially when inexpensive cylindrical nozzles are utilized, which are generally designed for approximately 3,500 psi operating pressure and are quite common to the pressure-washing and hydro-blast industries. A 200% increase in jet nozzles standoff distance can be expected. High quality cylindrical nozzles with operating pressures up to 36,000 psi will achieve up to a 35% improvement in standoff distance. The nozzle manufacturer's all-around knowledge in physical fluid technology

(Bernoulli's theory) and his mechanical production capabilities are most often responsible for vastly varying differences in nozzle-jet performances. Regardless, high-pressure water containing a 0.3% polymer additive enhances the nozzle standoff distance improving its water-jet structure. When in the market for a polymer metering device, it is important to recognize their operating precision. A polymer imbalance, whether positive or negative of a 0.3% solution, diminishes all advantages gained. Employing a trigger dump-gun design is not advisable; polymer costs are too high.

To avoid a breakdown of the emulsion, storage and operating temperatures must be kept at 40–90 °F. During operation, polymer hydration time following continuous injection to the system's suction tank must never be less than 2.5 min before actual use. Polymerization of pressure-washing or jetting water is highly debatable. Operating costs compared to the contractor's chargeable hourly rate are generally not profitable. It is also quite difficult to convince operators that adding polymers will accelerate a job completion. Consider a test with polymer-charged water when an extremely hard scale removal application must be performed and necessary tooling and psi–gpm performances are not available. Generally a fluid drag reduction is not of an advantage when high velocity water is responsible for removing coatings, corrosion, concrete and resilient industrial products etc.

By industrial standards, hydro-blast equipment produces an comparatively low fluid volume within its high pressure water application. Therefore, in the mid 1950s, the conversion to function as a hydraulic power source for the general mining industry developed into a feasible market identity (oil emulsions). Operating hydraulic systems, hydraulic cylinders and self-adjusting shields (longwall) in the performance of tunneling procedures was the first application criteria within the mining environment. Today, most hydro-blast equipment is simply converted to permit the pressurized transfer and circulation of oil emulsions, or on the jobsite facilitating the service requirement to operate a trigger-gun and variety of nozzle-lance and flex-lance assembly's.

The utilization of oil-based pressurized fluids is of importance when tank-cleaning applications or slurrification-agitating procedures are performed gaining necessary liquid–viscous product transfer characteristics to exploit the hydro-vac transfer, pumping and product separation method, or providing product feed to various industrial pump equipment and tank car–truck identities. This important application capability is especially helpful when oil-based products such as hardened bunker-seed and tar pitch require agitation to gain a semi liquid consistency dramatically enhancing removal times, or utilizing pressurized heated turbine oil for cleaning and removal of metal remnants in failed oil compressor gear-box equipment and their bearing lube oil supply and discharge pipe systems, including contaminated oil storage facilities. These application entities can be found in power plants, refineries, chemical industries, or on marine vessels and barges, in ship-holds and product storage facilities throughout the commercial and industrial complex. Generally pressures between 800 and 1,800 psi at 5–20 gpm tempered or heated oil is sufficient. Speciality nozzles, controlling oil vapor–mist effects are of necessity in confined areas or spaces.

GEAR - LIST AUTHORIZATION

Biosecurity, sanitizing, decontamination, chem. - concentrate applications

Customer & Company: Web site: e-mail:		Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:		Specify: ©
Job Review Performed by:			
Downstream chemical injector: Through abrasive injector: Foam nozzle: Upstream injection: Chemical metering: Admix to suction tank: Through flow restrictor suction side: Other:		Dual wand injection: Single wand-adjustable nozzle: Pump-up sprayer: Chemical metering pump: Other:	
Biosecurity	Decontamination	Neutralize	Acidize Sanitize
Polymer jetting:		Polymer metering pump:	
Polymer quantity:		Polymer hydration time:	
Chemical classification: Viscosity: Compressibility:	MSDS: Specific weight: Foam-ability:		Explain dwell-resident time : Flame-ability: Acidity:
Water borne non-film forming, breathable silicone sealer: Solvent borne sealer: Identify surface structure-friability and nature of substrate: Rinse procedure: Water-waste stream, filtration-recycling equipment: Verify essential tooling: Safety procedure: PPE-safety gear: Water-ricochet arrester device			
Itemize equipment: expendables, labor time, equipment times, etc.			

"Pasting" is described as a process which suppresses, fuses and seals or confines industrial dust and powder-like products in any given area. Hydro-blast applications in coal transporting tunnels and storage units, various product transporting systems, dust suppression in manufacturing environments, foundation cutting applications, etc. are in need of this pasting process. Wind whipped dust may impede a manufacturing environment and is unanimously considered a breathing-health hazard, which may also in accumulation form a highly-unstable flammable or explosive environment (substance). When working in such an environment, most often dust suppression is deemed necessary. The service provider–contractor should employ the formula of lowest fluid volume times its highest pressure; this produces a mist–fog matrix, applied either individually with a trigger gun and fog–mist nozzle assembly or with fog–mist nozzles affixed in a series to a rigid lance. Railroad cars transporting mine tailings or coal dust pass

Fig. 3.35 Water arrester, components-tooling

Fig. 3.36 Water-ricochet arrester device

through a stationary pasting unit to mist the open loads and fuse the outer dust–product skin; when desiccated protection against product loss by whipping-air velocity and subsequent unnecessary dust development is achieved. The hydro-unit's suction tank or an upstream injector is utilized when a dust-suppressing solvent or paste such as calcium-chloride is chosen (with a specific weight of 1.23 kg dm^3). When deciding on a dust suppressant chemical it is important to verify the liquid product's, low viscosity (water like), foam-ability and lack of abrasiveness to protect the pump's fluid-end (valves, etc.).

The constant water-dusting procedure is also applied in the suppression of airborne asbestos while performing dismantling, removal or packaging procedures achieving a low waste product wetting factor. A continuos air monitoring and sampling device must be worn to record and prove adequate air purity while performing this application. A simple water-ricochet arrester affixed to operators shoulder in close vicinity of nose–mouth-respiratory protection (Figs. 3.35, 3.36) will protect filter test paper from water-ricochet.

When sealing earthen walls-cavities to prevent water seepage into the adjacent ground or structure by providing and constructing a confined blast-water and refuse pick-up basin, airless coating spray systems, available most anywhere are perfectly suited to apply viscous sealing compounds which prove especially handy in small, confined areas when foundation cutting applications are practiced (rubber, plastic, foam).

GEAR - LIST AUTHORIZATION

Surface pasting-fortification, airborne dust suppression

Customer & Company: Web site: e-mail:		Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:

Job Description:

Job Location: Job Site Risk Assessment: Specify: ©

Job Review Performed by:

Industrial area: Mining industry: Refinery: Chemical industry: Other:			Tank cleaning: Dust suppression: Bag-house areas: Silos: Food processing vessels: Foundation cutting: (pump cavity) Mine tailings: Asbestos removal: Storage unit: Rail cars: Other:		
Equipment: Upstream injector: Downstream injector: Spray-bars: Nozzles: Orifice size: *Specify:* *gpm/psi.* Other:			Hydro-blast unit: Pressure washer: Airless paint sprayer: Water-ricochet arrester device Other:		
Method: Slurrifying: Agitating: Transfer oil emulsions: Oil -temperature-viscosity:			Bunker-seed removal: Pasting process: Dust suppression: Other:		

Viscous sealing compound:	*Specify:* rubber, plastic, foam, etc.	MSDS:
Dust suppressing solvents:	*Specify:*	*MSDS:*
Chemicals:	*Specify:*	*MSDS:*

Abrasiveness: Viscosity: Foam -ability: Combustible:

Describe application and work procedure:

Itemize further equipment, PPE-safety gear, expendables, labor time, equipment times, etc.

3.3 Clinker–Slag–Coke Removal, Kiln–Boiler–Furnace Cleaning, Thermal-Hot Scale Removal (Cracking)

When producing cement, etc. the continuously operating rotary kilns and mini kilns may sooner or later develop a product ring adhering to brick refractory reducing kiln's internal diameter, resulting in an accelerated product movement throughout a unit's interior. Due to this, internal temperatures will also raise disturbing kiln's temperature profile to undesirable levels during the manufacturing process. Extreme material accumulations may completely block the internal diameter in radial direction, forcing a production shutdown.

The 1950s method, to precisely aim a Remington cannon toward the clinker obstruction in a cement kiln (Fig. 3.37a, b) is not only outdated, but also very costly due to production time loss, shell and labor costs. The hydro-blast cleaning method embodies the thermal shock principle. High-velocity, cold-water jets fired in short bursts (water bullets) from a heavy lance (schedule 120 plus) in appropriate length, usually 15′–60′ or up to 90′ causes a thermal shock, cracking and breaking the cement clinker while the kiln slowly rotates in its production cycle. In this process, relatively small water volumes are applied conveying no appreciable cooling effects to the refractory and kilns internal operating temperature. The nozzle carrier (hard-hitter) pointed at a 5° to 10° angle produced by a curved 2′ lance tip extension will strike the clinker obstruction directly avoiding all water jet contact to refractory. As the kiln rotates, the lance will position itself enabling tool operators to precisely manipulate the nozzle with a minor rotation of the trigger gun-lance assembly (outer perimeter to the center of the kiln). A minimum of 10,000 psi and no more than 19 gpm are the input requirements.

Cracking rock-like formations while in a jetting operation, the general kiln clinker movement can momentarily bury parts of a rigid lance, which is considered an operational prerequisite. Clinker impacts to the lance assembly can be quite violent and will, do to kilns rotation, loosen right-handed straight or tapered thread assemblies (NPT); therefore, all lance couplers are machined and feature a counter thread (straight, preferred metric non-tapered left) to prevent possible loosening, water leakage and/or loss of lance. The kiln in rotation will naturally remove material from the obstructed lance permitting the constant movement necessary to pinpoint, within a jetting procedure, clinker formations adhered to the refractory structure maintaining a 6″ to 12″ nozzle standoff distance to brick formation. To protect the lance from melting or deforming a constant pulse cleaning method is adapted to guarantee adequate cooling by blast-water passing through.

Undesirable deposits also appear in the kiln's suspension and grit pre-heaters which may further prohibit the uniform production distribution throughout the chute and grit cooler. To accommodate structural exterior and kiln's interior circumstances within the removal of various clinker formations, the correct sizing of a hydro-lance and trigger gun assembly must be performed. This is facilitated by an array of high-pressure lance accessories in increments of 5′, 10′, and 30′, befitting the strategically placed service ports permitting adequate access to all

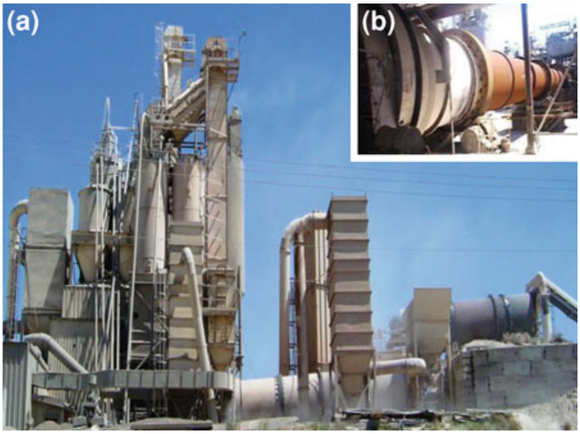


Fig. 3.37 **a**, **b** Cement kiln

important areas. Regardless of application, an aircraft grade steel-alloy lance material enhances tensile strength (up to 50%) and is superior in flexibility factors (bend and kink) in comparison to all other useful materials. Seamless, stainless steel tubes may outperform carbon steel by 25%.

It is not unusual that red-hot clinker fragments are hurled with great explosive velocity into the operator's area. Operators involved are to dress in fire-retardant, or best, in full fireproof safety gear featuring integrated heat and shock resistant eye protection (filter strength similar to a medium–heavy welding glass). Due to extreme heat, never allow a non-operating lance to remain in the fired kiln. It will result in irreversible lance damage.

Fossil fuel utility boiler: Clinker–slag development on the fireside of a fossil fuel utility boiler (steam generator) can be dramatic when the coals defined purity, firing, airflow and burner tip conditions, excessive service requirements or power utilization drops below the generator's operating specifications. The time frame for a clinker mass development is quite circumstantial and may develop over 12 months or possibly within a 24–48 h time frame. While in operation the early detection and clinker poking phase by maintenance personnel maintaining the fire room's process, maintenance engineers will in an emergency situation consider the simultaneous clinker–slag removal by hydro-blast thermal shock method.

Protecting suspended boiler tubes and the slag-ash grinder assembly from catastrophic clinker collapse possibly damaging the vital interior which includes the throat area of bottom ash hoppers or hoppers inner area depending on size of the firebox is their intent. Power plant personnel involved with furnace slag removal which is also referred to as clinker poking are almost always aware of the critical areas and considered next to maintenance engineering department the best info source for a contractor.

The hydro-blast removal method is also superior to the explosive blasting method in that the thermal shock application permits the adequate sizing of clinker debris in a controlled effort not to overpower the tube and grinder assembly. This stands also true when a clinker removal application is performed

under a general plant shutdown situation (off-line) and various hydro-blast technologies including a rotary nozzle design criteria is exploited. A clinker formation may develop from the bottom near the grinder assembly upwards or be suspended within the tube structure which can include the area of the burner assemblies. Inspection, service and overhaul access on boiler and steam-generators are situated upward of grinder assembly to the burner assembly area and are utilized to orient the lance-base armature to the required internal clinker areas. A counterweight located below the catwalk balances the jet's recoil forces, thus enhancing the operator's overall lance control. This permits lance operators to reach all developing clinker formations, including all of the lower temperature areas which are visually recognizable by a dull reddish pipe–clinker–slag tone (especially found in the unit's corners and bottom sections of the fire room). Approximately 10,000 psi, 30 gpm satisfies most circumstances encountered. 8,000 psi, 30 gpm have proven adequate in 80% of removal procedures, but is unsatisfactory when hardened clinker bulk disrupts its own flow to the grinder section of the unit. When hardened clinker bulk is encountered efficient cleaning time is of utmost importance. Apply the thermal shock method to all flowing and rigid materials, avoiding excessive interior cooling. A quick, operating response is essential and supported by a predetermined sizing and exterior placement of necessary high heat lance extensions fitted with quick couplers (trigger gun assembly) and situated near service ports as are all necessary high-pressure hose armatures are pre-installed. To offset the constant temperature loss within a continuous and sporadic jetting procedure is it important to establish a periodic, possibly ½ hourly time cycle to regain max operating temperature to then again remove clinker–slag flow restrictions and buildup starting at the cooler-cold side of a formation. It is essential to maintain the highest possible operating temperature to effectively clean and extract the available coal dust energy. Providing services to utility companies may require the utilization of 75–250 hp pump capacities, operating an array of industrial hydro-blast tool selections which can include dredging tools, sludge and dry product vacuum recovery equipment and supporting tanker–trucks.

Waste-oil, waste-product incineration utilities: Icicle-shaped ring deposits and incrustations appear every 6′–10′ in oil sludge burning systems where temperatures may reach 2400° to 3000°F. Furnace lengths range between 25′ and 35′ and depending on the make and type, measure 6′–8′ in their internal diameter. Incrustations are more likely to be found on the fireside of the units. A 20′ high-pressure rigid lance (schedule 80) and a unit at 7,000 psi and not more than 16 gpm are sufficient when removing these incrustations at full operating temperature. The thermal-shock clinker-ash removal method is also offered to the commercial–industrial waste and BIO fuel incineration–heat producing industry.

Refinery coke drums and headers; in short, all coke-handling equipment, including their chromium pipes (8″ plus circumference) can present a problem when contractors are not aware of the job location. The operator's free movement may be restricted by physical heights, restrictive locations and encountered horizontal and vertical distances between hydro-blast unit and actual job site and last,

but most important, the extremely hard and more often glazed adhered product found throughout a system's interior.

Coke shakers and their screens are comparatively simple to clean; 8,000 psi, 16 gpm is adequate and best applied with a 25° fan nozzle.

To bridge horizontal shaker distances which are possibly up to 25′, a ¼″ rigid lance (schedule 80) with T-form dual orifices neutralizing the nozzle's recoil forces enhance the operator's control and work procedure. When cleaning refineries chromium pipes the following aspects are considered: vertical heights, pipe diameter and overall length, coke products tensile strength and adhesion, and to prevent scale streaking appearances or events the correct nozzle and jet's standoff distance from the product-pipe wall. The contractor applying 20 two 36,000 psi at 9–15 gpm are the fortunate ones, especially when rotary-nozzle carriers reduce water jet standoff distances from the pipe work. Manually-operated block and tackle (¾″), such as those utilized offshore, permit an endless rope-feed and present a comparatively inexpensive application method.

Block and tackle are simply installed to the center of pipe structure to lift and transport nozzle carriers and/or ultra-high-pressure hose assemblies to any desired height or distance, eliminating the physically strenuous and otherwise possibly dangerous pulling techniques. Furthermore, this method permits the contractor to correctly accomplish the cleaning procedure by pulling, in controlled increments, the ultra-high-pressure hose assemblies, including the sometimes rotating nozzle carrier assembly slowly upward throughout the pipe system from the bottom of any given unit and in its wake producing a perfectly clean interior pipe surface. There are companies specializing in providing rigging assemblies of interest when repetitive work can be guaranteed or intended which in design is similar to smoke stack cleaning fixtures–apparatuses.

When coke drums, headers, flanges, etc. cannot be cleaned with ultra high-pressure water or a minimum of 14,000 psi, abrasive injectors such as concrete or steel cutting heads can provide effective removal of coke from steel surfaces when utilizing fine-structured or non-grit soft blast materials (soluble abrasive). This method also effectively polishes steel surfaces within the cleaning procedure. It is often found that interior pipe surfaces exhibit previously inflicted damage, therefore presenting a higher adhesion factor which escalates the material buildup when transfer processes are in action. A rigid lance fitted with two steel–concrete cutting heads in T-form (neutralizing the recoil forces), equaling approximately 5″ ½″ width, will allow material removal practices wherever rotating nozzle carriers may not be applied. The hose delivering soluble abrasives is affixed to the high-pressure water hose assembly.

Mill scale removal: Metal industries engineering groups are constantly striving to optimize the surface quality in their production of products in hot-rolling mills. The hydro-mechanical mill slag-scale removal method is not considered a contractor's cleaning application rather an equipment manufacturer's specialty. Steel industry product and process varieties also constitute within their mill slag-scale removal practice high-pressure water quench procedures to remove the excess mill slag-scale by thermal shock. Red-hot iron leaving the rolling mill is

GEAR - LIST AUTHORIZATION

Clinker-slag-coke removal, kiln-boiler-furnace cleaning, thermal-hot scale removal (cracking)

Customer & Company: Web site: e-mail:			Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:		
Purchasing: Tel: e-mail	Engineering: Tel: e-mail		Maintenance: Tel: e-mail	Safety: Tel: e-mail		
Job Description:						
Job Location:	Job Site Risk Assessment:			Specify:		
Job Review Performed by:						
Rotary kilns: Grit pre-heater: Suspension pre-heater: Grit cooler: Chute: Steam generator: Boiler: Grinder assembly:			Oil sludge burning furnaces: Garbage incineration: Coke drums: Chromium pipes: Coke-shaker screens: Flanges: Hot rolling mill: Others:			
Equipment: Hydro-blast unit: Schedule 120 lance sections: 5 -10 lance radius: Specify: Hydro-trigger gun: Lance extensions: Specify 5', 10', 30', (ft): Fire retardant-proof safety gear: Heat-impact-proof filtered eye protection:			Lance-recoil eliminator: T-lance: Nozzle carriers: Roto-spin jets: Specify: Rope-block and tackle: Abrasive injectors: Other:	 Length: Specify: Nozzle centralizer:		
Product encountered:						
Hazardous material:			Specify:			
Describe application and work procedure: Itemize equipment, safety gear, expendables, etc.						

introduced to a water fan-jet treatment under various water pressures. This starts with a stationary placed hydro-unit, producing from 300 to 14,000 psi and stock width depending 10–200 gpm. The forced rolling mills high-speed red-hot stock is introduced to a water fan-jet configuration mounted in an overlapping nozzle-jet pattern to a stationary spray-bar armature creating the quench process by thermal shock. Water volume is kept to a minimum avoiding or better controlling the cooling and/or production chill factors which are possibly a manipulative capacity as their production process may call for. Some companies prefer to install pressure accumulators throughout their system to arrest the flow characteristics customary to piston pumps. The hydro-power is delivered by spray-bars mounted across the rolling stock's face. The nozzle standoff distance determines the location of the nozzle spray-bar from the rolling stock and is selected and tested in the production process before the final nozzle fixation is completed. The applied fan nozzle degree, orifice size and horsepower–psi configurations are the determining factors. To ensure the water's pinpoint and thermal shock capability, the fan nozzles must be of the highest possible quality supported by very clean water.

Mill scale, a thin layer of brittle iron oxide can be removed with high-pressure water (35–55,000 psi) but this is not a function of a thermal shock to its surface, rather, it is a function of erosion produced by high velocity water jet.

Combining this with unmanageable cavitational influences involving imploding gaseous water molecules upon the mill scale surface results in a irregular product removal function and pitted surface appearance. The removal rate with high-pressure water of tightly adhered mill scale is commercially ineffective compared to available alternative means such as for instance by water abrasive blasting. Where mill scale adhesion or its interface appears in areas sporadic, lifted or eroded by corrosion and/or demonstrates a rust development within its formation, high-pressure water is very effective and of interest especially when surface tolerant coatings are to be applied.

3.4 Condenser or Small Tube Heat Exchangers, Large Tube Heat Transfer Units, After Coolers, Steam Generators, Three Drum Water Tube Boilers, Package Boiler Services

Condensers, boilers, heat and small tube exchangers (Fig. 3.38) are found in all major industries. Refineries achieved a certain independence acquiring contractor services by developing and installing stationary semi or fully automated tube bundle cleaning systems (Fig. 3.39) which service 1–6 units at a time. Nevertheless, major plant shutdowns produce a large exchanger variety in numerous service locations providing job opportunities to contractors well versed and tested in this industrial environment. Service providers utilizing high-pressure water as a tool also transferred their manual operating experience to semi or fully automated and mobile equipment available in various configurations. This type of equipment

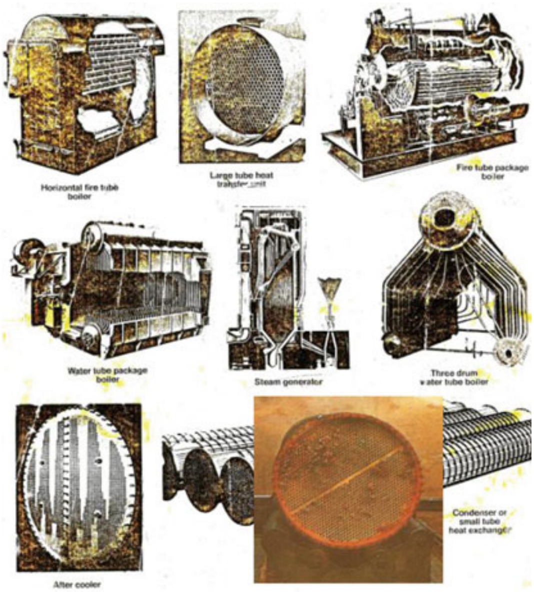


Fig. 3.38 Various boiler and condenser designs

potential can only be manipulated to its fullest capacity when manual cleaning methods and their criteria concerning condensers and heat exchangers is fully understood.

The procedure of tube cleaning is categorized into 4 steps starting with scale removal of the outer circumference (shell-side), including all tube surfaces into the center of unit, and is completed by cleaning the tube sheet of all products and gasket materials. Shell-side cleaning is also the least strenuous and time-consuming procedure. Product consistency and adhesion factor, the volume of product and physical tube design encountered will determine the technical form by which the external tube cleaning method is performed. Service location, bundle rotation and general accessibility, bundle exterior tube circumference, quantity of tubes and their formation, existing damage such as deformed tubes or sagging bundles and the actual width between tubes is a consideration. U-tube or straight tube design, products chemical category, as well as product hardness, adhesion, viscosity and hazardous categorization, the outer circumference fouling and characteristics toward the center of the tube bundle and finally necessary safety procedures are all determining factors which must be thought of in order to optimize the bid procedure, tool selection and work method. Manually cleaning condensers or heat exchangers outer tube circumference is considered tedious work (into the center of the unit); however, in most cases it is quite simple. The water-jet penetrating adhering debris or product structure tends to ricochet materials and deflected water into the direction of the trigger-gun operator, diminishing visual control, forcing him to rely on imaginative and systematic body mechanics. It is also imperative that all tube surfaces come in direct contact with the water jet operation. This again is achieved by a four-step jetting procedure and the controlled rotation of the tube

bundle being serviced. It is also helpful to identify and visually mark the cleaned tube area to ensure operators effectiveness; waterproof coloring pens or soft wires are good marking utensils. Refrain from utilizing heavy marking objects such as bolts due to the fact that the jets water velocity might accelerate them into a dangerous projectile. Most hydro or water-blast tool manufacturers supply short 1′–6′ ft, ¼″ in diameter (∅) trigger-gun extensions which incorporate a nozzle (round jet, hard-hitter) in such a way that permits the lance and nozzle retainer to fit between bundle tube structures. This achieves a shorter nozzle standoff distance from the product and results in a higher jet impact, especially helpful when large and compact tube bundles are serviced or exceptionally adhering and/or hard resilient materials are encountered.

In order to prevent renewed material adhesion to a cleaned surface, tar or sticky viscous materials must be suspended. Soapy or thinning additives are metered into the blast water. The common practice to heat blast water by introducing steam to a water supply or suction tank of a hydro-blast unit to mitigate tar-like products further adhesion possibilities will with certainty accelerate pump damage not only to the fluid-end, but also to pump’s gear-end structure.

Operating pressures generally vary between 2,000 and 22,000 psi, 5–19 gpm per flex-rigid lance assembly. An ample amount of face shields or tear-off visors, rain gear (PPE) and duct tape are absolutely essential. For various reasons, next consider the cleaning of both tube sheets and their specific areas (bolt holes, threads, gasket areas, and tube overlap).

Because a visual identification of possibly plugged tubes is impossible when servicing U-tube condensers, a simultaneous identification and marking of plugged (clogged) tubes on the tube sheets face is necessary during cleaning procedures. The verification promotes adequate safety precautions through the correct use of hydro-tools and further supports a better estimate for a job completion. Contractors working in plant are sometimes inclined to further accept tube bundles to the existing workload voiding the prior bidding process. A quick verification of tube soiling will prevent the embarrassment of presenting incorrect time estimates and overall cost fluctuations.

To verify the location of blocked tubes, install a high water volume round jet nozzle to the high-pressure trigger-gun operating quickly and precisely at medium pressures over all tube rows throughout the bundle face (4,000 psi). A suddenly developing water column will characteristically back-flush toward the trigger-gun operator, identifying a possible plugged tube. Intensifying jets velocity by pointing the nozzle directly into the tube orifice will often raise water pressure sufficiently to rupture the fouling point, eliminating the need for added attention. Mark plugged tubes with a cork slightly larger than the tubes interior diameter (∅) or mark the location on tube sheets face with a waterproof pen (Fig. 3.40). If there is adequate tube sheet drying time the cleaned but still plugged tubes will release products or seeping water, revealing their location. However, this method should not be fully trusted. Bent tubes creating water pocket-condensation can slowly release water which will mark the tube sheet, resulting in possibly incorrect plugged tube identification. To leave a favorable impression with customers, the

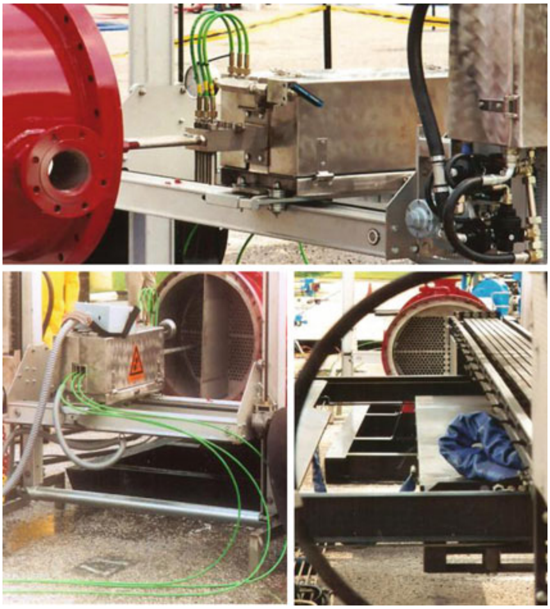


Fig. 3.39 Automated system mock-ups

Fig. 3.40 Marker tool characteristic

tube sheet's face should be cleaned with a short-barreled gun, with a 15° fan nozzle at approximately 8,000 psi. To further enhance the appearance an abrasive injector with a fine-light media (soluble abrasives 0.02 ∅ or less) at 4,000 psi can be applied.

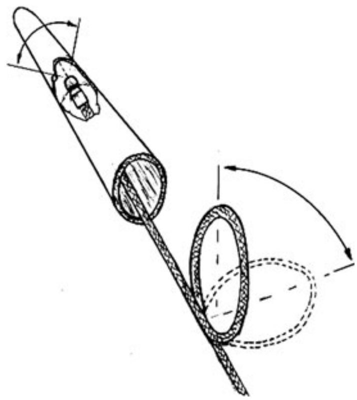
When operating a flex lance system in the attempt to clean heat-exchangers or condensers there are 12 rules which must become second-nature to all operators involved:

1. *Never* start job-rigging and cleaning operations before a prior adequate safety meeting informing labor force of corporate safety procedures (contractor) incorporating and providing a step in–out area for operators and their gear. Conduct in-plant safety meetings and familiarize the work force with the customers plant emergency procedures, which includes identifying in-plant shower and eyewash facilities.
2. *Never* come in physical contact with tube bundles waste product before a product classification has been established and safety gear is selected accordingly.
3. *Never* allow the operators to work over the threshold limit of their concentration and endurance. Injury is otherwise imminent!

4. *Never* allow the operation of hydro-rigid-flex lances unless the knowledge of stop–go–shutdown commands communication is firmly embedded into the operator's subconscious.
5. *Never* commence operation without gaining secure footing, sometimes difficult when viscous, oily products are removed.
6. *Never* operate without first properly securing the condensers lance-nozzle discharge side with tarps, restricting general surroundings with safety barricade tape, identifying hydro-blast operations and being aware and in control of water-debris flow, therefore avoiding the customer's anger unnecessary secondary cleaning procedures.
7. *Never* permit a rigid or flex-lance operation without a safety back-up man who controls either an emergency shut-of switch or a secondary in-line shut-off valve (foot valve). At all times the safety man must also be in constant and non obscured visual contact with lance operators, tube orifice, and hydro-lance equipment.
8. *Never* permit the handling or operation of flex-lances without adequate hand protection provided by industrial-grade chemical resistant rubber gloves. Cuts are inflicted by defective, contaminated metal spears protruding from covered hose braiding which may result in blood poisoning and infections. The rule applies, regardless of whether the lance is pressurized or not.
9. *Never* allow free lance travel into or throughout a tube avoiding the otherwise explosive return possibility of the lance nozzle assembly and simultaneous excessive hose kinking, which may result in a catastrophic lance failure and grave injuries to the operators (bursting or the development of nozzle-like orifices).
10. *Never* position the operator directly in front of the tube being serviced.
11. *Never* operate without gauging and limiting flex lance travel within ½″ beyond the tube exit orifice, thus permitting the cleaning of the total tube length and providing an acoustic sound identification of nozzle's location. It also protects the lance liner from otherwise premature damage inflicted by the tube edge to hose and nozzle armature.
12. *Never* after a job completion and after dismantling contractors equipment leave the job site avoiding the corporate tailgate meeting recording all job-related problems, successes, possible injuries if any and future possible job improvements. Following are three similar procedures described involving a 25′ condenser containing 400, ½″ tubes which are mud soiled, but open.

1. Mud scale is removed throughout the unit by simultaneously operating three flex lances, mounted to a three-pronged manifold which is an integrated part affixed to a primary foot valve assembly ahead of secondary safety valve assembly. The operating pressure is set at approximately 4,000 psi. The nozzle configuration is 6 orifices × 45° flat work, is best divided into × gpm performance of the available hydro-blast unit. Verify the desired water volume configuration to ensure adequate passage throughout the entire tool assembly

Fig. 3.41 Flex lance rotation



(horsepower requirement), including the high-pressure water hose, trigger guns or foot valves and flex lances. 6–9 tubes are serviceable per minute.

2. Hard scale throughout a condenser is removed by simultaneously operating two ¼-inch flex lance affixed to a two-pronged manifold which is also affixed to a primary foot valve assembly ahead of secondary foot valve-control. This permits the cleaning of 3–4 tubes per minute. The nozzle configuration is 6 orifices × 30° or 45° × gpm–psi (depending on the hydro-blast unit's performance). 8,000–14,000 psi is necessary in most applications of this sort.
3. Very hard scale is removed with a single flex-lance directly affixed to a foot valve ahead of secondary foot valve assembly. Depending on the hydro-blast unit, the nozzle in this case, provides 6 orifices × 30° × 22 gpm 20,000 psi (differs with nozzle manufacturers). The cleaning rate is reduced to approximately one tube per minute. Less cumbersome, but a gray area exists when a flex lance performs a job technically better-suited for a rigid lance procedure. When tubes are partially-fully plugged, the nozzle in use must feature an added jetting orifice (other than existing self-propelling jet orifices). This orifice is located forward, toward the center of the tube, removing all products encountered. An explosive hydraulic piston force toward the operator will occur when debris is permitted to form a tight seal between tube wall and nozzle (Fig. 4.5) assembly forcing the assembly "lightning fast" out of the tube.

This condition is prevented when a correct flex-rigid lance application procedure is introduced which includes the systematical rotation (Fig. 3.41) of the nozzle assembly in its forward and retracting cleaning procedure (35° to 60°) (Fig. 3.42). Permitting adequate spacing between nozzle-hose circumference and tube wall (Fig. 3.43) and/or encountered inner debris clearance must also be of first concern. Always secure a minimum of ten times the water volume produced by the forward orifice to pass between a nozzle-hose assembly and tube wall or its hardened debris scale. Most important restrict the free travel of the lance assembly. Incrementally and systematically clean tube walls completely in 4′–8′sections by

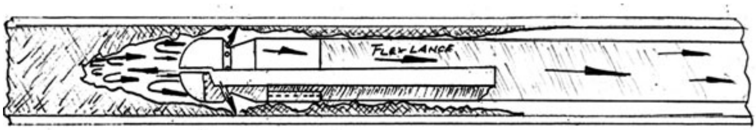


Fig. 3.42 Possible tight seal between nozzle-hose circumference and tube wall

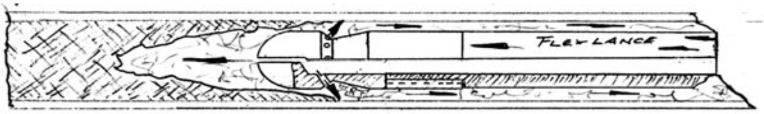


Fig. 3.43 Adequate spacing between nozzle-hose circumference and tube wall

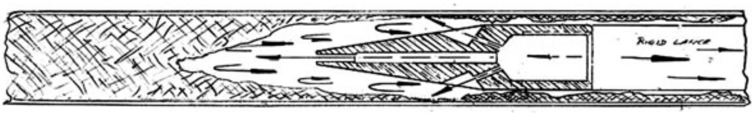


Fig. 3.44 Possible tight seal between nozzle-lance circumference and tube wall

removing all adhering debris before advancing the nozzle assembly further down the tube. This is especially of importance when paints, epoxy resins, synthetic latex, vinyl emulsions, etc. in solid and semi solid or various grades of viscous-sticky nature must be removed from plugged tubes. The same symptoms can be experienced when the nozzle tolerances itself to tube walls are critical, and the operator allows the uncontrolled propulsion of the nozzle-hose assembly into the tube structure.

Manually cleaning solidly plugged tubes is considered strenuous and time consuming, especially when rigid-lance procedures are required. Nevertheless it is the most effective cleaning method. Utilize the rigid-lance when extremely hard products, resilient or utterly viscous sticky materials are encountered. Cleaning results are achieved by directing the combined jetting force in various degrees toward the product and tube wall, releasing numerous jet-recoil forces upon the operator (Fig. 3.44), resulting in nightmarish operating conditions. Furthermore, the operators endure a constant bombardment of somewhat diffused, high-velocity refuse and water. If you must manually operate the rigid-lance, never operate a lance below a 3/8″ tube wall and more than 10′ in length alone; someone may risk wearing the lance around his extremities. As a 10′ rigid lance requires one operator, a 30′ rigid lance must always be manipulated by three operators; One to guide and pilot at the tube's orifice, one situated at approximately center of the lance pushing and guiding, and one to push and control the hydro-blast trigger gun (Fig. 3.45). Be sure of your verbal STOP–GO command system, because everybody's safety depends on it. Rotate the positions of the personnel as they tire.

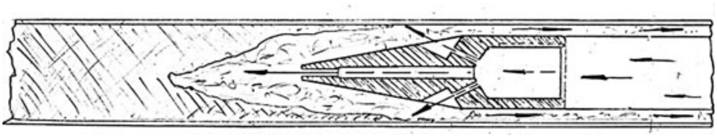


Fig. 3.45 Numerous and sometimes erratic jet-recoil forces

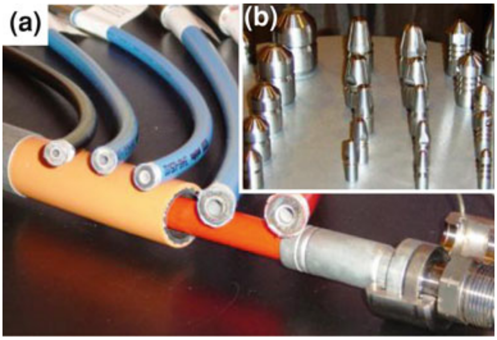


Fig. 3.46 **a** Various UHP hose interior ∅, **b** nozzles

Due to various undisclosed high-pressure hose/lance and available armature varieties ∅ (Fig. 3.46a), and/or hose run distance to a job site, combined with manually drilled soft metal nozzles (Fig. 3.46b) and their unidentified gpm performance is a scenario most often responsible for inadequate and/or a slow cleaning procedures. Completed hose-tool assemblies are best tested as to their pressure loss by removing all nozzles, securing hose-ends within a fixture open to atmosphere avoiding whipping while testing. Performing readout at systems pressure gauge operating at pumps predetermined rpm requirement will quickly identify the psi necessity to force set gpm performance throughout a tool assembly. Identifying and adding the subsequent necessary horsepower capacity to pump drives (motor-engine) overall performance capability within the designated power curve reveals systems true power input requirement and will possibly reveal an overload scenario most often responsible for pump gear-end and/or engine failure.

Shell-side cleaning is a simple application with various tool possibilities and it nearly completes a condenser–heat exchanger service cycle. Exterior bundle cleaning and when operators enter a shell directly to water or abrasive blast the units surfaces clean of debris is it required that an unaware by-passer's safety is guaranteed. Cordoning off the immediate work vicinity, restricting traffic with barricade tape, and post warning signs in visually-strategic areas is a must.

To verify operator's safety always double-check the plant maintenance department's previous lockout procedures (locks) concerning all flanges, valves and any pipes which enter the vessel, preferably adding your own locks. A vessel entry permit must be obtained and the recommended safety standards according to plant and OSHA laws must be followed. If shell-side cleaning becomes a daily routine, build a few simple tools to eliminate the shell entrance; for instance,

Fig. 3.47 Soiled condenser tube sheet

Fig. 3.48 Cleaned condenser

install a mobile tripod arrangement with an adjustable diameter to support T-lance configurations, dual abrasive cleaning heads, turbo nozzles, etc. Requirements of surface cleanliness vary depending on the visual, X-Ray or hydrostatic follow-up test procedures. The interior shell-side cleaning method more or less is similar to tank-sewer or surface cleaning procedures (confined space).

The condenser cleaning process is generally applicable when servicing large tube heat transfer units (Fig. 3.47) which physically may only vary in tube ∅ (mainly larger and tube length considered longer). A difference also appears due to the fact that tube bundles may not be extracted from their shell structure. The similarity between after-coolers and large tube heat-transfer units is obvious. However, here you will find that tubes in their numbers range from few to literally hundreds and tube size will not exceed ½″ ∅ (Fig. 3.48). A hydro-static test, also belonging to the contractors application variety is possibly required after units assembly in its location or while still in its service bay. A service provider should always remind the customer of this possibility. Nowadays highly mobile and automated rigid power-lance equipment (Fig. 3.49) and multiple or individual flex-lance cleaning systems are available and can compete various areas where the manual tube in cleaning procedure is deemed to cumbersome or time-consuming.

Three drum water tube boilers, usually categorized from 600 psi main propulsion aggregates to CK 60 commercial–naval units operating in their respective vessels from 1,200 psi, containing approximately 1300 tubes plus, which includes general industrial auxiliary boilers (manufactured by Foster Wheeler, Apco, etc.) are found everywhere in the industrial environment. In the past, circulating a 10% hydrochloric acid solution followed by a pacifying, neutralizing procedure was the

Fig. 3.49 Power-lance equipment

general internal tube cleaning method. In their physical structure there is no resemblance to condensers or after-coolers. However, the high-pressure water cleaning method for scale removal on or in boiler tubes is still considered a tube-cleaning application. Chemical cleaning, called for a final water flush of the unit, which is intended to remove all loosened scale.

Once applied, the hydro-jetting technique (1958) immediately proved superior and environmentally friendly displacing the chemical procedure. However, this excludes the pacifying–neutralizing flash-rust protection process of raw carbon steel tube surfaces. In the tube cleaning process service providers apply 1 lb. sodium nitrate per 100 gallons blast water, avoiding aggressive oxidation and rust-developing factors. To provide complete rust protection during the units drying time it is wise to lightly douse the complete tube and mud drum surfaces. Mud drums (bottom of unit) tend to be inaccessible or impractical to enter; the cleaning is therefore performed from the top down by entering the steam drum above the fire room. Tubes in older units (20 plus years) are up to 4″ ∅; generally expect 1¼″ ∅ to 3″ ∅ tube sizes. Tube quantities vary from hundreds to thousands, according to boiler's size-power, age, manufacturer and industrial use. Likewise for the length of the tubes; pressure-fired generating tubes are 14′–26′ long and their inside ∅ ranges from approximately 0.8″ to 1.67″ ∅. In a steam drum the longest tubes are found at the top of the unit. Tubes from the top to the center range from 47′ plus to 30′ plus and from center down to the floor pattern of the drum 30′ plus to 20′ plus. The tubes of a 40 year old Foster Wheeler unit (containing 600 tubes at 3½″ ∅) are 36′ to the center of the steam drum and then decrease down to 25′ in length.

At the time of tool selection it is important to recognize any changes in tube size, common in most units. These units can also be found in the food processing industry. Scales appear soft, hard, resilient or brittle and require an experienced operator to make an adequate tool selection. When the hydro-unit's water performance is limited, streak appearances in jet impact areas are likely, especially when large tubes bear hard, brittle and adhering scale (3″ plus). A 2″ whirl-jet (ultra high rpm) may compensate for this shortcoming with its jetting characteristics. To avoid the tangling of safety lines, high-pressure water hoses and electric cables, start the cleaning procedure on the far side of your entry, regardless of which side you initially entered the steam drum.

As the work proceeds a safety-man visually situated (confined space entry qualified) on the exterior of manhole which was entered by the operator will pull the slack of the high-pressure hose, electrical cable and safety line, providing unimpeded movement for operator in this cramped and confined environment. Knee protection is a must; the stubby tube ends will otherwise hinder the operator. The operation, of a one or two flex lance assembly or a ½″ ∅, high-pressure hose is standard; however, selection may vary depending on equipment water volume psi performance and pipe ∅.

Pressures of 7,000–14,000 psi are essential (product adhesion depending). Lighting is best supplied by a 12-V explosion-waterproof fixture. By installing fans or air-injection blowers to the manhole opposite the steam drum's entry, fresh air for cooling and breathing purposes is supplied. Important, "don't obstruct dedicated emergency exit". Again, never enter any vessel without having received all permits from plant maintenance department. Make sure that all boiler drains located at the bottom of the mud drum are opened and locked out. Furthermore, supply an emergency egress system which is fastened to the belt of the operator and an air back-up unit situated outside the steam drum in immediate reach of designated safety man. Manholes come in all sizes; to prevent a possibly deadly surprise ensure that the air back-up unit (Scott Air Pack, etc.) will fit unobstructed through manholes entry. The safety line may also serve as a means of communication; for example, one tug means feed high-pressure hose, two tugs means retrieve high-pressure hose, three tugs means activate high-pressure safety valve (safety backup), and constant tugging signals an emergency. In your safety efforts remember not only to concern yourself with your immediate work location, but also keep a keen eye on your surroundings, especially when a major plant maintenance procedure is in progress and various trades perform independently a multitude of maintenance operations.

Utility steam generators utilizing excessively contaminated fossil fuels, or operating with inconsistent oil temperatures which may result in a varying and/or faulty combustion, etc., can develop hard incrustations consisting of calcium, glass, copper, vanadium and so on which may adhere to super-heaters or generator tube surfaces. Deposits are removed on incline generating tubes by jetting them from three sides, hitting all tube surfaces including surfaces in depth of the tube structure. Super-heaters most often develop a clinker-glass like scale only within the first, second and third tube structure. By fitting a short-barreled gun with a 2′, 5/8″ in ∅, schedule 80 rigid lance, and incorporating the nozzle in such a way that the nozzle fixture does not exceed 5/8″ in ∅, the free movement between the tubes is possible, providing a greater water-jetting effectiveness. Secure necessary scaffolding, provide ample lighting, heavy-duty raingear, gloves, double face protection (face shield, eyeglasses) and top entry safety harnesses or, if suitable, safety belts and lines. Consider these items job essentials. Operating pressure may range from 8,000 to 22,000 psi, 19 to 10 gpm. To prevent soiling of previously cleaned surfaces, water-jetting procedures start at the highest interior point of tube structure. Various effective tools are available applying high-pressure water semi automatically.

GEAR - LIST AUTHORIZATION

Condensers, small tube heat exchangers, large tube heat transfer units, water tube boilers

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Plant hardware: Heat exchanger: Condenser: Boiler: 3-Drum water tube boiler: Mud drums: Steam drums: I.D. of tubes: Small tube exchanger: Tube-sheet: Shell side cleaning: Steam generator:	Tube type:	Nr.:	O.D. of tubes: Bundle rotation: Deformed-damage tubes: Sagging bundles: U -Tube design: Straight tube design: Super heaters: Gasket area: Fire room: Other:		
Equipment: Waterproof coloring pen: Chemicals: *Specify:* *MSDS:* Hot water: High-pressure trigger-gun: Flex-lances: Rigid-lances: 3-Pronged lance manifold: 2-Pronged lance manifold: Rigid lance cleaning system: Foot valve: Other:			Plant location: Vessel entry permit: Nozzles: Remote-automated jetting equipment: Lance tripods: T-dual abrasive cleaning head: Turbo nozzle heads: Rotary jet: 12-Volt or air-drive explosion-proof lighting: Rust-inhibitors, metering equipment: Knee protection: Other:		

Product hardness, adhesion, viscosity:	*Specify:*	
Fouling characteristics:	*Specify:*	
Physical surroundings, safety procedures:	*Specify:*	Others:
Describe application and work procedure:		
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.		

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:		Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:		Specify: ©
Job Review Performed by:			
Plant hardware:		Hydro-blast equipment:	
Plant location:		Equipment:	
Product Encountered:			
Hazardous Material:	MSDS:	Specify:	
Describe application and work procedure: Describe safety procedure: Itemize equipment, safety gear, expendables, etc.:			

Maintenance work on steam generators, as found in fossil fuel power plants, require the use of hydro-blast power in three categories; clinker removal, spot or total outer surface and internal ∅ tube cleaning of incline wall tubes and often followed by hydrostatic test procedures to visually identify tube leaks. Identified leaking tubes are replaced and/or welded, automatically requiring a follow-up hydrostatic test validation. Test pressures applied will vary with the manufacturer's specs and are usually 1.5–4 times the operating pressure of a steam

generating unit. When cleaning boilers or steam generators, especially when high water pressures are necessary, always be aware of the brick structure (fire-side); brick should neither be unnecessarily saturated by water (eliminating extensive drying times) nor damaged by high-velocity water jets.

3.5 Coating–Paint–Graffiti Removal on Surfaces such as Asphalt Concrete and Clay Masonry, Cementitious Wall Board, Structural Steel, Aluminum Surfaces, Wood Facades, Surface Flash-Rust, Corrosion-Oxidation Control

Electrostatic paint shop facilities are traditional to automotive assembly lines. They where first to exploit high-pressure water (1963) to remove cured thin-film and/or heavy paint accumulations by paint-misting from cabin floors and walls, grid-iron catwalks, air filtration equipment exhaust-ducts and hoods, flue stacks, sedimentation in water channel-systems and on chassis transport equipment, etc. Today's facilities are generally cleaned within the progression of a plant maintenance procedure. The high-pressure water coating removal technology, operating at up to 45,000 psi applying comparatively low water volumes does permit a protracted UHP trigger-gun operation incorporating a spin jet assembly. Elevated water volumes may be necessary for bridging voids or deep surface recesses facilitating penetration for a coating or substrate removal application and can require the utilization of a jet cart (rotating), eliminating all recoil forces upon operators. These applications are quite self-explanatory and mainly vary due to safety procedures enforced by individual maintenance departments or industries when considering the physical cabin size and various chassis transport equipment, product characteristics and volume, adhesion, elasticity, tensile strength and structural circumstances regarding underlying steel surfaces.

The blanket statement that 20,000 psi plus water pressure will effectively remove a cured coating or paint covering from various substrate is generally misleading. Psi–gpm configuration and the subsequent specific tool selection will significantly vary with every individual job description and might start in successfully utilizing 3,000 psi at 5 gpm with cold or hot water or manually operating two Spin-Jets at 40,000 psi and 6 gpm at a 250 ft^2 (plus) per hour coating removal rate. Throughout industrial and commercial environments, a successfully performed coating–paint removal application depends solely on the correct assessment of a substrate's identity, characteristic of its possibly present anchor profile or the identifiable surface roughness, identification of structural–surface integrity (corrosion, oxidation, friability), and consideration of potential variances in coating adhesion and interface makeup to substrate or the interface adhesion factors between coating layers if so desired. Further, the encountered multitude of preservation, restoration and/or cleaning requirements does include possible identification of prior coating–paint failures. This is most often identifiable by

coating delaminating, blistering, cracking, flaking, oxidation or corrosion resulting from previous inadequate substrate preparation or a past coating selection (system) impervious to the specific substrate and environment. The substrates rehabilitation and technical prerequisite in question must also include the consideration of its future repair, coating or seal performance criterion, which is an important identifying characteristic influencing the determination of a correct hydro-tool selection, subsequent psi–gpm–horsepower requirements, overall work procedure and surface preservation, between removal and installation of any new coating system. The available tool potential and its application flexibility, variety and safety requirements concerning the contractors' equipment ought to be fully understood by all involved. Therefore prior to a job commencement it can be necessary to include a application specific lecture as to the service provider's trade criteria involving customers maintenance superintendents, project engineer's and restoration architects, etc. Equipment-tool performances above 10,500 psi require an advanced tool design and application specialization regarding all applicable safety standards and/or necessary desired tool combinations. Equipment performance and its design criteria may vary substantially between equipment manufacturers and industries tool suppliers.

Testing a substrate to warrant a correct and practical removal assessment may also require scaffolding and containment procedures not yet erected or operational. Under these circumstances care must be taken to identify problem areas in obstructed, concealed, out of sight or physically hard to reach coated surfaces.

1. Traffic-line markings on asphalt–concrete substrate in pedestrian zoning, aviation and vehicular traffic areas (traffic/line foils-coating markings), or as found on interior and exterior parking facilities and/or game lines in amusement parks such as go-cart facilities, etc. are most often subject to erosion by surface abrasion to markings resulting in loss of glass beads or otherwise visual retro-reflectivity.

Traffic marking paints–coatings are classified as standard meaning non-durable or durable. Standard markings include solvent or water-borne coatings with fast drying characteristics. These coatings range in volume solids from 58 to 68% and their applied film thickness ranges 12–18 mills, dry. Durable traffic markings might also be a thin film water-borne paint incorporating fast drying latex binders. Often, a longer life traffic marking consists of a two component epoxy, polyester or two component polyurea and can include thermoplastics and/or preformed tapes. These durable coatings are of 100% solid materials. Their applied film thickness can range from as low as 12 mill to a high build of 40–120 mill (1–3 mm). Due to their VOC content applications are today limited. Regardless of coating type utilized (except foils) numerous recoating necessities can lead to peeling or flaking of coating layers. In most instances a prior and proper surface treatment is foregone since purpose is usually served with a minimal clean-up endeavor (often air blast only). This aloof coating practice does contrast to most construction sites where new road surfaces or frequently changing traffic patterns require imminent and sometimes simultaneous line removal-recoating procedures.

Manually operating a trigger-gun assembly featuring a 15° fan nozzle or single orifice spin-jet unit (Fig. 3.50) can in some areas be possibly exchanged for a

Fig. 3.50 Traffic-line removal

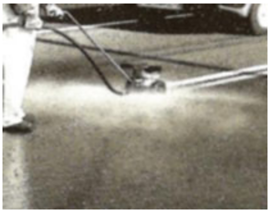


Fig. 3.51 Coating-foil removal

Fig. 3.52 Damaged bituminous product

water soluble and inert abrasive blast application removing the shortest of traffic line coatings. The exploitation of conventional air abrasive blast techniques can be viewed as marginally applicable due to health and environmental impact. Also equipment layout necessities in often restrictive areas, and a likelihood of possible wind swept abrasive-dust contamination prohibitive in aviation and/or sensitive manufacturing environments, etc. are occurring difficulties.

A variety of hydro-blast tooling can be manually operated (Fig. 3.51) or is found affixed to a mobile platform. These mobile units also incorporate a vacuum reclaim source (wastewater, coating debris). The mobile water source, hydro-blast unit, and spin jet assembly which, besides its narrow set or adjustability in removal width, can remind in functionality of a runway rubber deletion unit. On surfaces of an asphalt-aggregate basis, water pressures of 7,500 psi up to 12,000 psi are utilized, on concrete surfaces up to 36,000 psi. The gpm performance will vary regarding to traffic line width, coating depth and interface adhesion to substrate, substrate condition and original intent of the available tool design. The UHP jetting method and specifically designed equipment encompassing this application can also be mobilized for removing coatings in a measured procedure, avoiding damage to the substrate and edge structures such as those found on runway drainage grooves.

2. Bituminous product installs (Fig. 3.52), which insulate surfaces such as on pipes, trusses, siding and flashings, etc. are, due to their metal substrate, simply

Fig. 3.53 Concrete interface restored

Fig. 3.54 Coating liner removal

removed utilizing fan or spin jets (Fig. 3.53) with pressures generally ranging from 5 to 14,000 psi). The location of these surfaces may require extensive tarp procedures and water discharge control measures.

3. Surfaces requiring the removal of deteriorated or failed elastomeric proofing products or the removal of bituminous deteriorated game surfaces on water-residential–commercial tennis courts are also applications largely overlooked. Jet carts work well in this general product removal application. When properly adjusted the soft underlying bituminous or rubber-like court structure can be maintained while removing or cleaning the on-court painted markings only. The qualified contractor will manipulate nozzle size, determining necessary psi–gpm performance, the necessary rpm by nozzle degree (adjustable) to surface stand-off distance by judging desired penetration parameters within the paint structure and adhesion interface to the substrate (Fig. 3.54). Adjustability of cart's rotating nozzle carrier relating to the nozzle standoff distance is critical and must be precise in its function. Depending on tennis court's substrate condition, operating pressures range generally between 7,000 and 10,000 psi. Applying hot pressurized water may also be of an advantage when temperatures can be maintained above 200°F.

The total removal of a tennis court base is a standard procedure and can be supported by a vacuum-truck operation, which requires only a few tools to rake up and collect shredded base material which generally maintains a low water wetting-saturation. A hazardous waste removal procedure is most often incorporated.

A strong concrete substrate may destruct at approximately 8,000 psi plus, when nozzle standoff distances, water jet size or degree, and gpm performances are incorrectly manipulated or a prolonged stationary nozzle impact time to surface is permitted.

4. Laitance, sealers, brittle encrustations or resilient thick coating removal applications (40-mil plus) on horizontal, vertical and overhead concrete surfaces as found on decks and stair cases, parking areas, drive-thru or driveways, deteriorated primary containment (tanks) or lining–coatings for secondary containment, and/or

Fig. 3.55 Intact interface

coating systems on warehouse flooring, etc. are often found within the commercial environment. As in the industrial criterion the correct identification of a substrates condition and coating interface characteristic must be achieved and understood (Fig. 3.55). This is especially important when comparisons to conventional thin or thick film coating and/or concrete paste removal methods, including surface profiling–roughening, require creating an anchor pattern, producing maximum adhesion are considered within a bid procedure. These conventional methods may include the dry abrasive blast application utilizing an air driven vacuum collection system or operating a centrifugal wheel shot blast unit, steel shot blasting, wet abrasive blast techniques, impact and rotary impact tools, which include needle-scaling tools and large mechanical scarifying equipment.

Today's advanced vacuum assist high-pressure water tools manipulated by trained personnel prove superior in most areas to the conventional tool utilization especially when the water filtration, recycling and refuse separation capacity is added. The environmentally friendly, and in its process super clean remaining surfaces will standout especially when creating surface roughness or various profiles-heights into the corner structure of a prospective surface substrate. The physical and chemical properties and possible variations of concrete surface (Fig. 3.56) appearances seldom compromises removal applications between (penetrated sealer) −0 to 4 mils (−0 to 100 μm), or the removal of thin film to high build coatings between 4 and 40 mils plus (100 to 1,000 μm plus). Also these application and tool developments accelerated the design characteristics of emerging electronic-digital scale and roughness gauging equipment and includes the destructive coating thickness gauging criteria, which is often the only guaranteed method to test certain coating-substrate and interface combinations applied to concrete, wood, plaster, etc. permitting the identification of individual layer thicknesses of a multilayer coating system. Also pictorial concrete surface standards are established and produced by various industrial identities including the WJTA, SSPC and NACE associations. To their membership they provide a knowledge base concerning advanced test procedures for surface cleanliness (salt, chlorides etc.), coating adhesion verification, substrate pull-off testing and moisture gauging fundamentals under various climatic conditions which include steel surface preservation techniques for various job descriptions and coating varieties.

Fig. 3.56 Simultaneous waste stream recovery

Regardless of any coating deletion which suggests either a mechanical or hydro-tool selection, one must exercise an in-depth substrate research procedure to achieve and verify the possibility of a visually smooth, or undisturbed, and if, desired roughened and/or coarse but overall uniform surface appearance. The determined results can dramatically enhance, or for that matter, guide to a correct tool application in particular when the opportunity exists to obtain the original records of the prior surface condition to the first and now deteriorated coating installation. Deteriorating coatings and possibly the concrete paste structure or its interface might conceal possible problems which may arise due to structural damage, rebar-metallic corrosion (rust-copper stains), concrete paste flaking or cracking caused by settlement or delaminating paste due to abrasion repairs and physical damage, prior oil–chemical-acid saturation, resulting carbonation or due to coating damage from earlier freeze–thaw cycling to cement paste or substrate by moisture–water seepage and/or concrete surface variations due to unnoticeable and/or faulty concealed repairs.

Further more, there is a concrete failure possibility introduced by a potential chemical reaction (internal attack). This can be noticed when an inconsistent surface paste strength or aggregate surface weakness is present. The bond and interface strength to concrete is specified in psi (300–450 lbs.) or as is stated "concrete fails before the loss of bond".

The experienced contractor will employ this information to avoid presumption when choosing the set-up of his tooling. When applying pressures above 6,000 psi a light weight steel sheet strong enough to withstand approaching water turbulence situated beneath the jet-car at its operating starting, finishing or turnaround point prevents ghosting or damage to the concrete surface (Fig. 3.57a, b). The labor force may move this sheet, utilizing the masking effect when operations are started or ended. Black rubber high-pressure hose assemblies tend to leave streak-marks when pulled over hard porous concrete surfaces; to prevent this keep hose slack on the surface being cleaned.

5. Removal applications of nonskid coatings installed to resist harsh chemicals and heavy steel or rubber-wheeled loads which are found in chemical processing and storage areas, health care, institutional or educational facilities, food processing or meat cutting areas, automotive manufacturers and dealers, aircraft

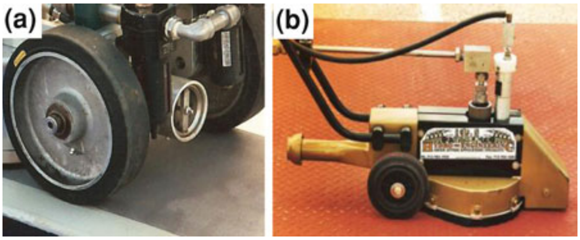


Fig. 3.57 **a**, **b** Jet-carts offering simultaneous waste stream recovery

hangars, equipment assembly lines or product sumps-trenches and secondary containment areas.

These older advanced floor systems are often comprised of 2–4 layers, starting with an optional elastomeric membrane, followed by an epoxy prime coat. The third layer is a matrix of grated, at times colored, abrasives (quartz) and 100% solid epoxy to provide the necessary strength and chemical resistance. The final coat, also an option, consists of a clear epoxy finish which adds extra protection and an attractive gloss. When removing such coatings the following aspects must be established: Identify the makeup of the sub-floor (brick pavers, butt metal, quarry tile, concrete, or wood), its condition and in particular, its condition prior to the original floor installment. Restorations are performed to accommodate a new process–product or equipment expansion, etc. Often industrial coatings are applied to damaged, badly eroded, poorly cleaned and prepped floors. Aged floors are possibly uneven or pitched therefore a cured deteriorated epoxy coating (self leveling) may also vary in thickness in surface areas not easily identified (described in mil.) If it all possible, retain floor manufacturers physical property sheet, and coating identity generally specifying hardness in shore (70–85), compressive strength which is commonly between 17,000 and 19,000 psi and tensile strength between 12,000 and 13,000 psi.

6. A coating, adhered to a floor substrate constructed of tile allows a similar removal practice. Industrial tile grouts are generally super hard preventing damage by high-pressure water and therefore do not require specific attention. The individual deletion of coating layers may prove difficult due to the floor's irregularities. When coatings are removed from a brick substrate, the possible interface malleability does demand close attention. The spin-jet's adequate rpm adjustment, removal transfer tempo, gpm–psi and nozzle configuration (including nozzle standoff distance) must be thoroughly tested to avoid brick-grout and/or brick surface damage on soft-core bricks.

7. Concrete coatings–sedimentation–spatter deletion on job related equipment and tooling can sometimes be expressed within a coating removal classification. Cleaning concrete form-boards (Fig. 3.58), which are normally coated with a bond breaker for easy removal after curing, can be considered an equipment maintenance function as is the cleaning of scaffolding, exterior and interior concrete truck surfaces, cementing vehicles and all concrete-related tooling. Applying a high-pressure trigger gun, fitted with various lance extensions and equipped with a hard-hitting round jet nozzle, and/or single orifice turbo-nozzle and sometimes simply

Fig. 3.58 Dismantled form boards

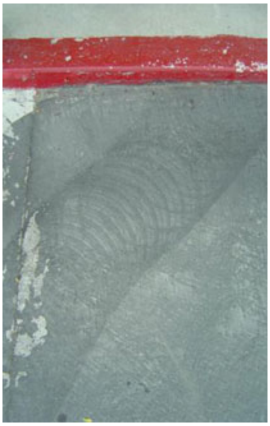
Fig. 3.59 Fan-jet ghosting

utilizing a 15° fan jet at pressures from 3,000 to 14,000 psi at 3–22 gpm can be considered customary to the industry. Ultra high-pressure water applied with specialty tooling in areas or spaces (concrete-drums) to remove hardened-cured product.

When applying lower water pressures at insufficient gpm performances a product or product film destabilization may be necessary. Muriatic acid can in some instances be applied to cement-concrete residuals supporting the desired breakup. Most store-bought muriatic acids are measured in 20° Baume at 31% by weight.

Cement-concrete film or film like residue may be treated with 1–5 parts acid admixed to ten parts water supporting product film separation from its surface by cold or best hot high-pressure water. When objectives are accomplished the area of application and surroundings are best neutralized by a low-pressure water-wash similar to the acid neutralization performed after a conventional acid profiling endeavor with water acid ratios equaling more likely 1 to 1. Always verify the surface neutrality by means of a simple pH paper. Trigger-gun lance-barrels featuring an adjustable blast screen will aid operators in visual control while adding extra protection from flying debris. Under these circumstances an uncontrolled wastewater runoff to a storm sewer system is illegal. Form-board bond breakers are

Fig. 3.60 Jet-car ghosting



generally formulated from oils, greases, silicones, waxes and/or cured polyurethanes (form-release agents) and are the culprits in leaving residual material upon newly poured surfaces, which must under most circumstances be removed to permit a satisfactory bonding of coatings. After a 6 week curing time surfaces to be coated must be handled with care avoiding concrete paste damage, visually identifiable if a thin film coating is installed. Contaminated paste can be cleaned free of residue by various standard methods. Cleaning with hard-hitting round jets is not advisable due to subsequent surface ghosting. Much of the available equipment can be altered by a fan jet curriculum, supporting psi and gpm performances suitable for nozzles capable of a 25° to 65° spread. Pressure and water volume configurations are set to cancel out all ghosting (Fig. 3.59) possibilities on newly poured and cured concrete surfaces (Fig. 3.60). A secondary option exists within this application to provide a surface or roughening procedure (anchor profile) at various degrees supporting a superior thick-film adhesion factor most often suggested by coating manufacturers. The notion or opinion that cold high-pressure water will force surface oils or greases deeper into a concrete substrate is untrue and misleading. Today's vacuum assist spin-jet technology outperforms any other solution, especially the steam cleaning application when combined with various emulsifiers, solvents or detergents. Heating a concrete substrate with steam will only enhance a deeper concrete contamination.

8. Commercial aviation's taxi, parking and jet-bridge areas are also outlined with paint indicator lines-stripes and are in need of periodic restoration when they appear visually faded or require a removal application due to constructional and/or operational traffic changes. Sometimes a dual surface application can be encountered due to adjacent concrete–asphalt tarmacs. Self-propelled or hydraulically-driven spin-jets are most suited for this application. They offer a physical and technical water jetting adjustability while performing a simultaneous vacuum assist refuse removal capacity forgoing area contamination and cleanup procedures. Care must be taken to avoid ghosting characteristics or damage when in the vicinity of asphalt surfaces bordering a concrete tarmac. Pressure and gpm

adjustments must be performed before any operation can be introduced to a softer asphalt–concrete blacktop. Also, spin jets self-propelled and/or mechanically rotating nozzle carrier extensions must safely clear all recessed and lightly protruding runway markings or light fixtures. Manually operated spin-jet carts are ideal when working in obstructed jet bridge boundaries visually identifying equipment complexities. Jet cars designed to remove highway road markings feature two orifices within the width of a standard road coating line-marking. The versatility of these units is ideal. Contractors can apply them to spot clean surfaces or to remove rubber-paint-coatings including 3 M foils. When spot resurfacing practices are performed by utilizing higher pressures they can also be applied to scarify concrete or asphalt substrate, especially in physically confined or hard to reach areas. Operating pressures and gpm performances vary substantially between available tool designs and application fundamentals ranging from 7,000 to 36.000 psi producing up to 36 gpm.

A single or multi-gun operation is possible (fan nozzle or spin-jet fitted), and sometimes necessary within this application environment. Under these circumstances airports' safety requirements concerning the labor force and equipment placement are somewhat more elaborate and include fastening safety barricade tapes securely in most likely a wind-swept and high traffic area, strategically placing weatherproof warning signs-cones restricting access to trigger-gun operator's work area, and while in operation eliminating water-misting conditions often introduced by inexperienced operators.

Equipment and accessories must be located so as not to interfere with the movement of planes, jet bridge tires and their mobile structure, fueling, and baggage operations in case of an unforeseen operational emergency, general maintenance endeavors and airfield vehicles. An environmentally sound water soluble abrasive material which leaves no trace can sometimes be applied. A multitude of grains are available to polish, edge, hone and/or remove materials. Nevertheless a vacuum assist wastewater and refuse removal capacity is most often mandatory.

9. Deteriorating coatings and their substrates such as clay masonry units or pressed extruded brick surfaces and concrete masonry CMU's (Fig. 3.61) as found on block or brick structures and include stucco walls and soffit elements can be either solid or hollow core. Their manufacturing processes are extrusions or form pressing operations. Today's block densities are much lower than older units (Fig. 3.62). Due to highly developed high strength cementing materials and the substitution of sand or gravel with low density aggregate such as clinker residual admixed as fillers, industrial or various pumice byproducts, etc. which can lead to a greater substrate moisture penetration and often advanced by deteriorated coatings-sealers and/or environmental influences. The moisture can leach soluble calcium compounds from mortar joints, and/or develop mildew growth accelerated by coating flaking; peeling, cracking and blistered surfaces with visual symptoms appearing as white chalk like powder or calcifications known as efflorescence are also identifiable in areas of coating failure to the substrate. The available selection of water soluble abrasive blast-media enhanced application varieties greatly within

Fig. 3.61 CMU coating removal

Fig. 3.62 Cleaned CMU block surfaces

industrial and commercial environments. Possible substrate diversity does not permit a one size fits all coating removal solution. Extreme substrate friability may require prior chemical treatment to compromise a coatings adhesion to its interface, and then supported by a gentle water-wash (45° to 65° fan jet) utilizing equipment starting at 500–3,000 psi with hot or cold water, eliminating damage so often produced by spatula. Water volume and a specific tool design for each application which can include making use of the scouring effects produced by water soluble abrasives with a grain size specifically chosen for its desired surface manipulation does reduce common labor intensive job descriptions.

10. Deteriorated paint or coating removal applications producing lead residual often found on dilapidated commercial and wooden structures most always require an industrial cleaning and waste-removal approach. This will trigger automatically all applicable OSHA standards for worker protection, including a constant air monitoring process, and prior blood testing of the labor force establishing the allowable baseline or evidence of pre-existing unacceptable blood contamination. State and federal laws concerning the hazard classification, transportation, storage, and waste removal techniques when controlling–eliminating a possible airborne lead dust activity while in a removal process is of quintessence. High-pressure water as the primary tool is especially effective when blast-water is recycled within the water cleanup procedure utilizing a final phosphoric filter component

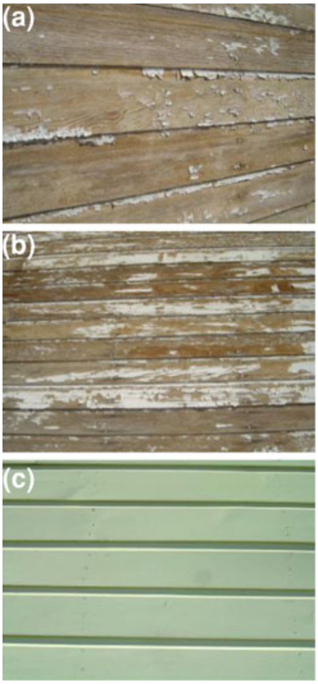


Fig. 3.63 **a**, **b**, **c** Wood restoration

removing lead trace elements from the recovered water. Before removing lead containing paint from exterior wood, stone or brick surfaces, several protective measures must be undertaken. Exposed soil surrounding a dwelling must be covered with a 6 mill plastic that should be attached to the bottom of the building with duct tape or other fastening methods. The 6 mill plastic must extend a minimum of 14′ away from the dwelling. If the pavement surrounds a dwelling, a plastic covering may not be necessary except to envelop drains in the area. Once the water jetting process has begun, the lead paint will drop off onto the plastic or pavement.

The hydro-vac method is ideal to separate blast water and simultaneously fill 55 gallon drums with the semi dry coating waste. Regardless of correctly packaged semi dry refuse a Hazardous Liquid–Solid Waste Permit is required to transport drums to a licensed hazardous material dump site. It is essential that operators wear gloves, facial protection, respirator and full rain gear. Under no circumstance can digestion by skin, mouth or air be tolerated.

Moderate or severely deteriorated paint-coatings such as those possibly exhibited on exposed laminated beams and columns, dimensional lumber, wood panels-façades (Fig. 3.63a, b, c), decks, staircase-steps, shingles and/or shakes which will most often also reveal a variety of wood substrate damages to be first classified cleaned and/or repaired before an adequate coating or staining solution can be determined. Numerous coating layers may also hide hazardous materials such as asbestos and lead often found on older building structures and public

works projects requiring containment and disposal procedures. With regard to those the high-pressure water cleaning–recycling technique is superior to conventional abatement methods when quickly removing all loose and delaminating, cracked flaked-peeling paint-coatings, which includes paint-coatings with an inferior interface makeup (bubbled). Within the removal process, mildew, oil and grease stains will also become obvious and visually enhanced by the subsequent drying process. Low volume–high pressure water administered with a correct fan nozzle and jetting degree will not over saturate wood surfaces. The operator must identify existing damage to the substrate, eliminating in his application procedure the raising of wood grain and ghosting appearances.

Exclusively and not subsequent to an incorrect water jetting procedure, the drying process can be distorted by remaining coating remnants developing the tendency of edge curling and wood grain splintering also due to the raised grain drying process. After surface drying this occurrence is simply manipulated with a mechanical belt sander, plastic spatula, brush etc. Avoid the use of steel or copper wool when cleaning or removing such surface adulterations. For a long time to come, caught wool fragments in the protruding grain will produce discolorations in newly applied stains-paints and coatings.

Regarding various wood restoration requirements and/or techniques, a coating mitigation and the following combination of chemical cleaning and neutralization procedures of wooden façade components is always best supported by a gentle and neutralizing water wash. A variety of paste and poultice concentrates for coating removal applications and neutralizing–cleaning products are specifically designed for this job criterion. Best results are achieved in testing products as to their coating deterioration characteristics enhancing the following water jetting and neutralizing procedures. Specific chemicals support a super gentle coating removal technique requiring a diluted ratio of up to 4 to 1 parts of water. The only practical way to determine the best mixture is to conduct tests on the substrate in question. After testing procedures are completed rinse patches thoroughly and allow them to dry. Once dried the cleanliness of the patch is obvious and any discoloration, ghosting or whitening of wooden substrate must be further cleaned and/or neutralized. Chemicals are applied by injector utilizing volume control by its metering device, brush-roller and/or airless pump systems. Often restoration projects will not allow scraping by wooden, plastic or steel spatulas. A trigger-gun with a refined fan-jet assembly and the appropriate gpm–psi configuration is far gentler within a compromised coating removal procedure. As to the initial process of a coating removal endeavor, this decision varies with every job description. Starting at the bottom of a structure and applying the solution evenly upwards is often considered the standard but can result in substrate surface discoloration and water saturation if not correctly addressed. Sometimes, a failing or deteriorated coating may protect the substrate sufficiently when starting on top of the structure. Regardless, after a dwell time of 15 min (or as specified), rinse the surface free of product and residue by applying 500–2,500 psi at 2.5–5 gpm. In some instance, rinse pressure must be reduced to levels prohibiting further interface modulation to extremely damaged or friable surfaces. However, it is important that all chemicals

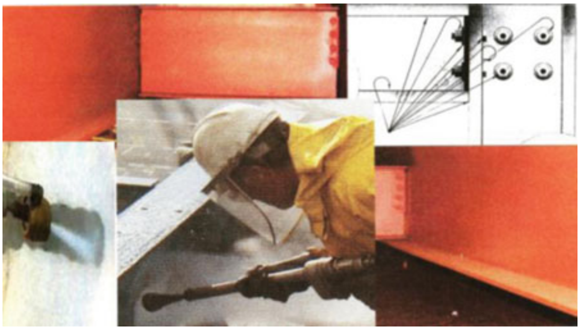


Fig. 3.64 Interior–exterior structural geometries

be thoroughly removed, leaving substrate and surface interface with a neutral of pH 6.5–7.

Wood variety, remaining original tool markings, environmental conditions or exposure, chemical influences, façade neglect and age and/past restoration and/or structural repairs almost always result in an slightly irregular surface appearance which must be carefully evaluated. Only when secondary cleaning-neutralization procedures are completed and surfaces are completely dry can a correct assessment as to the surface preparation and final coating installation be performed.

Also within a job bidding process, consider the wildly varying containment cost protecting human life, structures and environment. Fluctuating within every job description or application, pricing can vary from \$0.10 to \$0.80 ft^2 and does not include the hazardous waste removal, storage or treatment–placement cost.

11. Paint, coating and rust removal applications on structural steel and metal surfaces such as on columns, beams, joists, etc. flues, stacks, pipes, tanks and so forth are nowadays quite one-dimensional. The application problem only arises due to encountered structural circumstances. Job specifications and, also customary to available air abrasive blast equipment, the physical hydro-tool limitations can be challenging. A limited nozzle access to interior or exterior structural geometries is supported by a hand power tool application. Bridge structure, interior ship-hull, and tank configurations may require a 1–5% surface treatment by alternative tooling. Industry tool dimensions and development for or within a specific job criterion may vary substantially due to available manufacturing and engineering means. Besides service providers competing, partially responsible for this tool dilemma is the resulting product liability, engineering and manufacturing capacity–flexibility when tools are developed on a short notice for a not so often recurring job specification.

The distinguishing advantage of high-pressure water to resist dispersion and its ricocheting capacity especially when laden with abrasives will outperform air abrasive blast techniques (Fig. 3.64). The tooling required may vary drastically and can be of a permanent or quick exchangeable design. The challenge will always be to effectively reach all hidden and obstructed surface areas within a coating or rust-corrosion deletion procedure. A service provider is best advised to maintain a close relationship with his tool manufacturers engineering department.

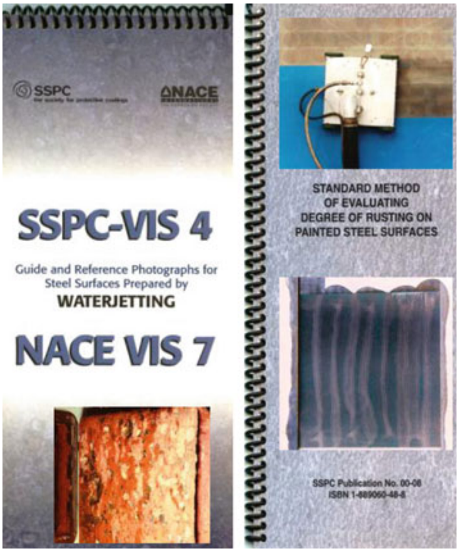


Fig. 3.65 Reference photographs

As to steel surface preservation and drying methods performed simultaneously, immediately after and/or as a periodical endeavor in a coating-rust-corrosion removal application to control flash rusting events are a technically developed criterion. Flash rust expansion intensifies especially when metals are newly active due to a hydro-blast coating removal or hydro-abrasive blast performance exposing the surface–substrate. Environmental circumstances such as location, humidity, cool damp days, inadequate tarpaulin procedures, time frame between cleaning and coating application, etc. are only a few factors which may accelerate a potential surface problem. Paint-coating applicators work systematically and often in tandem with the coating removal crew in that; coatings are removed for 4 h and then followed by the coating procedure. Applying and utilizing the SSPC and NACE international guide and reference photographs for steel surfaces (Fig. 3.65) prepared by the hydro-blast and UHP jetting methods are of great guidance toward a superior coating deletion procedure and the selection of a new coating system. Latest coating developments also result in industrial product lines stable under a certain degree of permissible flash rust development with not so circumstantial improved coating adhesion parameters.

The visual coating and rust removal reference performed on various steel surfaces is identified as water jetting, WJ-1, clean to bare substrate, WJ-2, very thorough or substantially clean, WJ-3 thorough clean, WJ-4, light clean. Surfaces can show variation in texture, shading or color tone resulting from environmental influences, changes in metal pitting, mill scale, type of steel and probably its original surface condition, differences caused by the initial abrasive blast technique creating an anchor profile, abrasive size, sharpness and prior blast patterns.

Flash rust comparisons are identified as no flash rust, light moderate or heavy. The direct removal of wastewater and coating refuse by jetting equipment

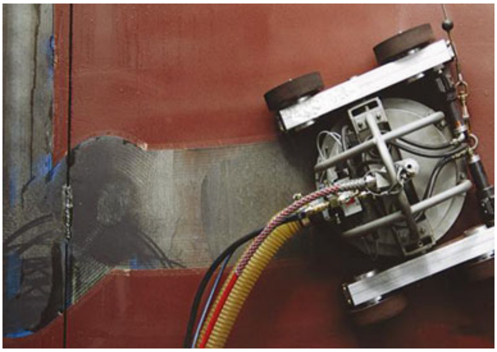


Fig. 3.66 Simultaneous refuse removal

(Fig. 3.66) incorporating a vacuum function will reduce the severity and extend the time frame of flash rust expansion as will the elevated temperatures to steel surfaces resulting from the release of kinetic jet energy and friction (surface-heat). Removing the soluble contaminant and sodium chloride or salt from steel substrates within a coating removal process is a superior high-pressure water application advantage unattainable by other means.

A corrosion inhibiting procedure must not negate this advantage. Since the mid 1960s, thousands of industrial steel-base units were hydro-abrasive blasted, primed and coated prior to their equipment assembly. In all imaginable industrial environments the delivered final equipment product in either mobile or stationary form has never exhibited a recordable coating weakness or failure due to a high-pressure water abrasive blast procedure or its technical uniqueness.

Chemical corrosion inhibitors should only be applied when a coating manufacturer can assure that their product is compatible to a flash rust inhibitor in question. Liquid or soluble inhibitors can be sodium nitrites, phosphates and benzoates or amino materials such as amino methyl propanol, etc. Precise metering procedures of such chemical inhibitors regarding to level of concentration in blast water as a direct application or by roller and/or airless system is imperative. Controlled are also surface drying times and avoidance of wind swept dust situations, inhibitor pooling possibilities on cleaned surfaces where evaporation may result in concentrations limiting a coating adhesion or promote future coating blistering and delaminating. Coating applicators will follow coating manufacturer's corrosion control guidelines to guarantee adhesion specifications. A loss of coating adhesion and/or osmotic blistering is likely when manufacturers' specifications are disregarded. When large areas or areas of difficult access must be inspected, flash rusting events may occur before a visual and physical inspection can be performed. Under these circumstances and before jobs initiation, the creation of various test patches, offering the required surface cleanliness and recording the drying times, ambient conditions and subsequent possible flash rust development or its severity can establish an overall guideline as to the total expected substrate cleanliness.

On interior steel tank flooring, besides trigger-gun operations, spin-jets or jet-cars are the preferred tool identity for exerting pressures between 10,000 and 45,000 psi; removing all coating or elastomeric layers to expose an even gray steel structure. Coating removal rates range from 50 to 250 ft^2 per hour. The vacuum recycling ability will eliminate nozzle misting and fogging due to ambient temperature variances, as well as those circumstances which are controlled when utilizing manually operated vacuum assist equipment for corner and vertical work. This does not mean that a continuous process of moving air throughout the confined space in question facilitating dehumidification and evaporation is foregone. Often a coating application includes air heating-filtration within the interior confirming an adequate ventilation procedure. The balance between the return air flow, dehumidification, temperature and relative humidity must constantly be monitored controlling a possible flash rust scenario. A stable sub-floor also permits the removal of individual layers, in particular when a base elastomeric membrane is present. This may add to dehumidification time due to water trace saturation within the remaining coating. Precise jetting parameters are achieved by the manipulation of jet-cars correct forward speed, rpm and gpm–psi configuration combined with the available nozzle variety and adjustable nozzle stand off distance to the elastomeric membrane.

Aircraft-carrier flight decks may also be an example of when nonskid runway coatings must be removed or serviced within this application standard. The tarmac sub-structure, built of steel, will constitute no applicable pressure limitations for the contractor, other than naval job specifications. These specifications are identified as to; total base removal, base spot removal practices and rubber or paint stripe removal. Tooling consists of a skid or mobile dual axle-mounted hydro-blast unit with an automated traversing single or multi-head spin-jet assembly, water-refuse filtration and tank either located on the plane elevator nearest to the work site or in the flight decks' bay area, low and high pressure-hose runs are kept to a minimum.

The actual psi requirements are often comparable to coating removal applications on oil–gas pipelines or fuel tanks with stringent safety regulations; however most ships are serviced on pier-dock site therefore do not require an operational flight deck. Besides naval specifications contractors' safety requirements are geared to the marine industry criteria. Steel surface preservation is a naval standard introduced to the contractor and must be followed explicitly. Water pressures range between 14,000 and 40,000 psi, gpm performances according to applied coating removal-width and subsequent hp availability. At times it is necessary to upgrade and install a secondary water filtration element to avoid contaminated water from pier or vessels potable water supply. All operational, coating removal, hazardous waste-refuse handling and safety procedures are specified by naval yard operations or their sub-contractor and include all asbestos coating or insulation removal deletion applications.

12. Even though the removal of graffiti (tagging) on various substrates is included in this chapter (Figs. 3.67 a, b, c), it is impossible to determine an adequate solution when lacking the on-site investigation identifying the appropriate cleaning

Fig. 3.67 **a**, **b**, **c** Varies graffiti events

Fig. 3.68 Vacuum-UHP jetting

or removal method. Most often vandals vent their creativity by utilizing a location advantageous to their message criterion. Therefore all conceivable areas or surfaces are subject and include residential–commercial–industrial structures, public buildings and restrooms, mass transit vehicles, stationary or rolling industrial equipment, etc. (Fig. 3.68). Acrylic latex paints, enamel spray paints, chalk and the ever evolving coloring variety delivered by highly durable aerosol cans, and/or crayons, ink, dyes, lipstick and powerfully formulated marking instruments are the stain producing paraphernalia. The vandals prefer presentation sites, where achievements stay on display for an extended period of time. For any contractor, difficulties arise due to the mostly unknown colorant adhering to a vast variety of painted or coated concrete compounds and/or stucco concrete paste and exposed aggregate surfaces including synthetic brick and fired brick, their mortar joints, tile, CMU block (Fig. 3.69), concrete surfaces poured in place, tilt-up or cast-in place (Fig. 3.70), wood, vinyl or various natural stone substrate, etc. This is exaggerated by varying surface porosity, possible substrate damage and unknown interface adhesion factors, discoloration of the interface makeup by unidentifiable pigment and environmental influences resulting in that no single removal technique by high-pressure water and/or chemical method exists.

Fig. 3.69 Masking graffiti

Fig. 3.70 Cast concrete panel

Fig. 3.71 Visually blending into cover graffiti

Indecision by affected property owners as to the deletion of the visual expression will only attract further or repetitive tagging activity. Visually blending in by painting over affected areas (Fig. 3.71) will result in an unattractive substrate and possible future building damage due to air flow restriction, moisture and/or mold development. A new, smooth appearing paint-coating (improved canvas) will also invite further tagging activity. The temptation to employ a novice professing professionalism within this application criterion is risky business. Needless surface ghosting manifestations or irreparable surface–interface and substrate damage might occur when an untaught utilization of water jet energy via equipment producing modest 1,500 psi-plus and a rotary spin jet or 15° fan nozzle at 5 gpm is allowed.

Fig. 3.72 Damaged CMU-block and concrete surface interface

As this example illustrates not only was a sacrificial coating removed, the contractor also created permanent ghosting effects by damaging CMU block and concrete interface (Fig. 3.72) structure into substrate depth.

Providing pictorial proof as to prior successful job completions on similar substrate accompanied by detailed job report and customer information is always of a great advantage for an aspiring service provider as it can also be an educational tool for prospective customers' job reality.

Next to an arrest, a customers' perseverance in maintaining a graffiti-free structure is the only real deterrent. Responding to vandals' endeavors within 8–36 h (max), exhibiting qualified cleaning procedures and the installation of either sacrificial or better permanent anti-graffiti coatings is paramount. This action is the preeminent deterrent especially when a substrate appears miraculously untouched or the new endeavors will not adhere and/or shrivel in the drying process. Ideally, the previous performed removal application will require property owners only to utilize a light high-pressure water wash supported by an environmentally friendly detergent when recurring tagging events appear. Nevertheless blues and greens are generally more difficult to remove then reds and blacks.

A gentle or delicate graffiti removal process on porous substrates such as concrete or its surface paste, masonry aggregate, brick, sand and limestone, etc., is performed in correctly identifying and chemically destabilizing the graffiti accumulation from its surface. After an adequate dwell time (chemical) and before light buffering abrasives are utilized is it important to follow the graffiti outline by applying a 15° fan nozzle to remove all loose or soluble coating residue to avoid all damage to the substrate. Hot pressurized water is almost always of an advantage on porous substrate.

Ghosting or removing the faint outline of a coating can be problematic if a minuscule layer of substrate is not to be manipulated (interface).

Spray paints composed of solvents which evaporate depositing pigments and their adhesive require a straightforward removal technique of the appearing central

Fig. 3.73 **a**, **b** Abrasive blasting

pigment concentrations (poultice-solvents), and is followed by the neutralizing pressure-washing application and barrier coating installation.

Pigment originating from metallic oxide or a synthetic compound adhering to a surface can require the chemical breakdown of the ionic force (static). Chemically introducing an extremely high level of hydrogen activity is specifically helpful when supporting a high-pressure water ghost removal application which proves successful time and again. The industry also developed penetrating chemistry directly applicable by metering device and trigger-gun application supporting pressure-washing endeavors on various metal, vinyl, wood, and painted–coated surfaces.

And then there are phantom graffiti remnants that can chemically simply not be removed requiring the versatile water-jet abrasive technology (Fig. 3.73). Alternative blast media such as cement powder (Portland), nutshell, sodium bicarbonate or a fine soluble buffering abrasive with a relative soft, 2–3 on Mohs hardness (scale) will achieve a superior interface cleaning procedure visually avoiding interface manipulations or interface and substrate damage. These products are especially successful for or within minor job descriptions. Comparative inexpensive abrasive injectors, trigger-gun mounted, fitted with a fan jet-barrel permit the introduction of a controllable scouring effect.

The utilization of solvent based products such as lacquer thinners, acetones and chemical paint removers of unidentified origin must never be introduced to a surface. They may not only discolor adjacent substrate but will leave a pigment laden discoloration within the interface area of a coating removal procedure. It must also be assumed that unidentifiable chemicals are of hazardous origin thus requiring product identification. If identified, the MSDS information will almost always require adherence to an assortment of local and federal recovery laws and safety requirements. Anti-graffiti products should be non-toxic, containing no ethylene chlorides, chlorinated solvents, methanol–methyl chloride, toluene, or acetone.

The recommendation of a chemical product for various coating destabilization procedures should always be supported by its manufacturer. The necessary

information retrieved includes the identification of preferred brush, roller or spray equipment, necessary environmental conditions while the work is performed (temperature–humidity), chemical adhesion characteristics and required dwell time, coverage rate on various substrates considering applicators tool requirement (brush-roller application requires more product), competitive pricing per square foot, applicable safety procedures and product identification (MSDS). Most chemical manufacturers have established methods or recommendation for a cold or hot low or high-pressure water rinse technique and if necessary specific neutralizing procedures of a substrate in question. A service provider performing various job descriptions within this coating removal procedure is well advised to consider vacuum–recovery and water filtration–recycling equipment, as it is important to understand necessary and always changing tarpaulin procedures.

Selecting a breathable, non-visible sacrificial or non-sacrificial graffiti barrier is a question most often confusing to a customer. The coatings work on the same principle in that cleaned porous masonry surfaces are protected against paint soaking into the pores, subsequently adhering or producing a discolored interface structure. The choice between none or a sacrificial treatment depends on the frequency of attack, substrate type, location, visual nuisance factor, human or vehicular traffic conditions, climate and various unlawful or depraved messages, eat. A variety of water soluble, water-based and breathable (wax type) sacrificial graffiti barrier coatings are available. They must be reapplied to a surface after a graffiti project and barrier coating are removed simultaneously. Some sacrificial, semi and permanent coatings require a specialized base coat installation.

There are a few non-visible or non-sheen producing coatings available supporting a repetitive graffiti removal practice (5–7 times). Substrates introduced to this type of barrier coating must be approached with suspicion. This does include prior treated surfaces such as historic limestone and sandstone façades, structures or areas and their design variants. These coatings can also be dramatic if imminent or future repair and/or tuck-point endeavors are desired on brick walls repelling the necessary grout adhesion. Most often it is quite impossible to verify past cleaning intervals and graffiti removal methods. High-pressure hot-water removal temperatures should not exceed 200°F to avoid possible stain-pigment setting of unidentifiable coating remnants in the interface structure. A contractor unaware of substrates service history and products utilized in the past should be cautious as not to create irregular surface appearances due to variances in a barrier coating adsorption. Within the coating application one must also be vigilant to avoid barrier runs which are often rolled or smeared out by a novice applicator creating discoloration or darkening effects when remaining wet film thickness, absorption and drying times are dissimilar to the primary coated surfaces. Varying a barrier coating identity, property owners ought to be made aware of, or find it acceptable that a minor darkening or gloss enhancement to the substrate appearance might be possible. A uniform coating application exhibits an equal surface wetting appearance within an application process. Wind disturbance of the spray pattern is more often than not the culprit in an uneven surface application procedure.

Inspecting and testing a substrate as to a future visual quality and achievable adherence-penetration of the desired coating and its performance and/or equally the proposed graffiti cleaning–removal technique, operators–applicators test substrate–surface absorption parameters randomly and then the desired cleaning method on small and visually out of the way, least noticeable and/or arbitrary areas before an overall cleaning and re-establishment of a barrier coating is performed. A visual variation can be produced within the absorption coefficient of a substrate and must sometimes be addressed within a dissimilar cleaning method.

Also the possibility to feather in visual surface irregularity or appearances by a pressure-washing effort can be greatly influenced as to its success by varying substrate absorption or adsorption parameter and/or positive charged pigments (ionic charge).

The application of water based coatings (wax type) are performed in mild temperatures above 40° to 50°F facilitating an adequate product mixing and emulsification avoiding otherwise a possible visual surface remnant (gray sheen). Generally, barricade coatings require 3–6 h drying time, temperature and humidity pending, as they also may require a second coat expanding drying times up to 72 h. To estimate the coverage of a barrier coating per gallon applied for metal is approximate 600 ft^2 per gallon requiring one application, on sealed and painted–coated wood or concrete surfaces also one application at approximately 450 ft^2 per gallon, on painted concrete block (CMU) with two applications, proximately 400 ft^2 per gallon, on stucco, brick, fired brick, concrete block or cast in place, also with two applications, approximately 300 ft^2 per gallon. A cleaned surface dry and prepared requires approximately one labor hour to install 2,000 ft^2 of barrier coating. These estimating values are approximate and vary dramatically between job applications due to new or historic substrate, unreliable adsorption or absorption, varying surface porosity, substrate hydraulic conditions, temperature and humidity and/or applied product characteristics and applicable environmental standards.

Non-sacrificial breathable barrier coatings can be silicone based products, or coatings based on several major resin chemistries with silicone and polyurethane based materials providing a long-term service life, despite repeated graffiti removal applications by high-pressure water. These coatings enhance bonding to the substrate, resisting water, oils, and paints ore marking materials. Penetrating treatments of this type will provide anti-graffiti properties but will not alter the look of the substrate.

Various coatings are available, and can be chosen to harmonize with the existing overall installation utilizing a universal tint machine. Coatings range from relatively low-cost acrylics, to better performing polyurethanes and epoxies, some of which can be applied to metal surfaces. Penetrating silicone based treatments are generally not suited for metal, various smooth stone, and to some degree even hard glazed brick surfaces, nevertheless they are most effective in warding off ghosting effects. As to an overall general and detached judgment, one can only say that a hard, non-porous impermeable and relatively smooth surface is inherently much easier to clean and protect than a permeable porous (soft or hard), or very rough and/or heavily textured substrate.

GEAR - LIST AUTHORIZATION

Coating - paint - graffiti removal on steel, concrete, stone, brick, and wood substrate

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: State:	P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:

Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Structural circumstances: Horizontal: Overhead: Vertical: Confined space: Vessel entry permit: Hazard classification: identify: Access procedure: Scaffolding: Tarpaulin procedure: Vegetation: Aquatic environment: Traffic control: vehicular, pedestrian: Effluent control measures: Coating waste control measures:	Friable: yes: no: Lightly: serious: Limestone: Sandstone: Stone: Brick: Mortar: classify Concrete: Wood: Aluminum: Steel: Coated steel: Other:	psi?	Coating deletion: Alternative abrasive: Chemicals: dwell time: Detergent: dwell time: *Specify:* *MSDS:* Cold water: gpm: psi: Hot water: gpm: psi: Soluble paint-coating: yes: no: Rinse method: Barrier coating: Sacrificial -permanent One code: Two codes: Flash rust inhibitor: Other:
Test Equipment: Soluble salt meter: Thickness gauge: Pull-off adhesion test: Surface profile gage: Surface moisture meter: Nozzles: Hydrovac-system and Vacuum-box: Water filtration and recycling: Abrasive injector: Other:			Coating installation specifications: Airless paint sprayer: Chemical metering equipment: Ventilation equipment-procedure: Dehumidification equipment: Other: Patch testing method: Areas:

Coating, tensile strength and adhesion:	*Specify:*	
Physical surroundings, safety procedures:	*Specify:*	Other:
Describe the work procedure:		
Itemize equipment, safety gear, expendables, labor time, equipment times, etc.		

Fig. 3.74 A preventable ghosting event

In today's restoration and/or construction domain, preventive technologies are available for new or restored concrete surfaces, providing both the structural and aesthetic requirement. The two-in-one concrete curing and graffiti control product which also protects the structural substrate from expansion, contraction, and temperature extremes is quite versatile. Protecting against graffiti, these coatings are impervious to ultraviolet rays, ozone, salt water spray, and acid rain. These coatings contain fluorinated high slip anti-stick additives, which when vandalized prevent adhesives from adhering to coated services (stickers) and will while applying graffiti shrivel the colorants while inducing product slippage down wall surfaces. Possible minor remaining trace elements, will wear off with normal weathering. Paint ghosting scenarios (Fig. 3.74) are simply removed with a low pressure washing application. Because this coating is applied to new concrete the product bonds with the substrate aggregate. After adequate concrete curing (28 days plus) and coordinated with the following form board removal endeavor coatings are simultaneously–immediately applied producing an approximate 2–2.5 mil wet film thickness.

3.6 Concrete-Aggregate Cutting, Scarifying, Surface Preparation, Demolition and Restoration

During the Roman Empire, buildings, bridges and water pipelines were constructed using a building material known as opus cementitious, a mixture of burnt limestone, loosely added rock, and water. The technology used then was lost, only to be rediscovered 200 years ago with the use of a product known as Portland cement. In 1867, the Frenchman Monier added steel reinforcement, enhancing the strength of the product we know as reinforced concrete. The high alkalinity pH value of approximately 12–13 prevented the corrosion of concealed steel, making this a highly successful process. Concrete is a product containing limestone, clay, and various aggregates, is sensitive to acids, salts, carbonation and concentrations of sulfur dioxide (SO). Hardened, it is susceptible to micro fractures, often a result of structural tensions, mechanical or hydraulic-driven impact tools, and erosion by mechanical abrasion. Edge spalling of joints, spalling by impact and environmental

Fig. 3.75 Concrete deterioration

Fig. 3.76 Light aggregate removal

shock resulting from sudden climatic change and/or freeze cycling (Fig. 3.75), etc. are added circumstances a concrete structure endures.

Under favorable atmospheric and internal conditions, a general deterioration of exposed rebar (steel) expanding up to six times its original volume can accelerate surface discoloration and damage in depth any susceptible structure. However, a prematurely deteriorating concrete substrate may also be the result of an incorrect specification, or construction process.

A repair or rehabilitation project requires the removal of deteriorated and damaged concrete aggregate (Fig. 3.76). The removal performance by high-pressure water is adjusted (gpm–psi) to the damaged concrete interface zone avoiding all further negative influences to the remaining intact concrete matrix. Compared to all mechanical removal methods the unproblematic determination and recommendation as to the necessary area of attention (removal depth) of an affected concrete substrate will prove vital to a job estimation criteria. Subcontractors also should be aware of concrete repair strategies proposed or introduced to a restoration–rehabilitation endeavor in question.

To circumvent performance challenges, the service provider best understands all possible causes including wear and tear criteria to the structure in question.

Fig. 3.77 Repaired damage

Fig. 3.78 Deep UHP aggregate removal

As much as he should understand the following repair methods which hopefully address the root cause of the concrete's deterioration-symptoms (Fig. 3.77) facilitating an estimation process requires close cooperation of its property management. All physical access constraints and environmental obligations must be considered as does the structural safety during the test procedures. The presence of a structural engineer is always advisable, identifying all added load classifications by equipment and reduction through removal of concrete mass in the tested areas (Fig. 3.78). If reinforcing bars (rebar) are exposed during a demonstration or test procedure, the steel structure should be treated with a corrosion inhibitor. Extended time periods between an investigative process, bidding and the final job initiation also requires the protection of exposed rebar structures. Assorted coatings and/or a suitable primer and/or zinc-rich paint cover can be applied.

Removing deteriorated or damaged concrete in inaccessible areas to or below the rebar structures can best be achieved by using a trigger-gun starting at approximately 14,000–43,000 psi. A variety of straight and rotating nozzle configurations are available. To ensure visual control and operator safety, an adjustable splash guard is affixed to the gun barrel. At these pressures, the recoil energy developed by a jet must be controlled or offset to a physically manageable force. Do not reduce pressure; reduce equipment water volume performance instead.

Cleaning and slightly enlarging stress fractures and cracks to accommodate polymer modified concrete grouts or chemical grouts reacting to form a gel or

Fig. 3.79 Concrete slab, before–after

Fig. 3.80 Concrete aggregate cleaning

solid are applications often encountered within structural restoration projects. Appearing cracks and/or fissures have many causes and can be the result of weathering, mechanical or thermal stress, settlement and shrinkage or faulty construction process and design. Regardless of cause, a high-pressure water jet is most suitable for cleaning and preparing cracks vertical and horizontal surfaces gaining the desired adhesion factors. The contractor must choose tool criteria by correctly identifying the desired application, which can affect the appearance only or be structurally significant. This can only be achieved once the extent and reason for the cracking-fissure developments have been established and successfully managed by either preventive maintenance or justified reasoning.

Exposing aggregate gravel on concrete slabs (Fig. 3.79), traditionally performed by rotary steel brush systems on production sites, sometimes in combination with acids or multiple acid applications, is being successfully displaced by today's high-speed spin-jets rotating a single jet about its axis (Fig. 3.80). The nozzle standoff distance will be approximately 1–1½′ above the concrete surface. Required pressures range from 3,000 to 5,000 psi.

Manually-operated spin-jets can produce cleaned areas of approximately 45 square yards per hour, thus utilized in large area applications representing triple the production capacity of a single trigger-gun fan jet assembly. These values are based upon a 6–8 h aggregate drying time. Hardened surfaces (Fig. 3.81) demand the use of spin-jets at 6,000–10,000 psi, producing a cleaned area of 25–35 square yards per head per hour. Nozzle standoff distance will again depend on nozzle size

Fig. 3.81 Before–after, aggregate cleaning

and rotating speed, effective nozzle spray pattern, available horsepower input and tensile strength of concrete adhering to aggregate (gpm performance).

A single fan jet operation is often impractical when cleaning large soiled vertical concrete slabs, building facades or ornamental surfaces. The spin-jet assembly is capable of cleaning up to 90 square yards per hour, effectively avoiding surface ghosting appearances. This is achieved due to the enhanced nozzle standoff distance, subsequently resulting in greater area coverage. Alternatives to this application are based on chemical power. A concrete cleaner (acid) is applied to slab surface by an injector or roller, etching the slab surface structure to the point where 2,000 to 3,000 psi at 4–5 gpm and a 45° fan jet is adequate to clean and neutralize the substrate.

Due to the restoration and preservation varieties on buildings of all ages, materials and there designs, hydro-blast and/or UHP tool requirements will differ drastically as does the support equipment which must facilitate those varying operations. Gaining jobsite access, protecting the construction site from falling debris, controlling water accumulations, water-misting as well as performing adequate tarpaulin procedures are variations, dictating the choice of specialized tooling.

Removing concrete-mortar in a controlled manner is often supported by pre-cutting (diamond blade) and establishing area identification (Fig. 3.82a, b), subsequently providing a smooth edge configuration. After concrete-mortar removal this also supports an aesthetic least visible to repair fill application. Care must be taken as not to cut into to the rebar structure. The blade angulations' pointing to healthy or hale substrate supports and enhances adhesion capacity of various repair material. The blade degree is also determined by mortar's aggregate size to protect edge structure within the removal process.

Controlling the aboveground construction site while performing a cutting, demolition or scarifying application differs substantially in its technical requirement

Fig. 3.82 **a**, **b** Concrete edge precutting

to underground operations. This includes the area of foundation-footer cutting (Fig. 3.83) or structural concrete removal techniques (Fig. 3.84) in high-rise basements', subterranean construction sites such as pedestrian, vehicular, rail and subway tunnels, and in the interior of water dam or mining facilities, etc. Within an application procedure these areas can or will be classified as a confined space.

Most often a subcontractor status exists to a general contractor which requires a combination of, traffic, general construction safety, additional trade logistic controls and advanced environmental application technologies such as for instance water filtration and recycling procedures. Hydro-cutting, scarifying–roughening or demolition applications may depend on specific structural circumstances requiring an impact-vibration less, atmospheric non volatile, heat-less and explosion proof procedure avoiding all water pooling, saturation and rubble or waste accumulation possibilities.

Concrete cutting or removal applications will test a subcontractor and contractor's ingenuity with every assignment involving multiple trades. Backhoes and bobcats are employed to excavate exterior foundation of soil, creating a cavity large enough to facilitate the necessary movement for operator and high-pressure water tooling. This includes creating a designated area for accumulating debris-rubble and a 17 amps or equivalent submersible float-actuated trash pump with a capability of transferring four times per minute the water generated within an application criteria. It is prudent to include a backup source proficient to function independently and under any mitigating-unforeseen circumstance. The hydro-vac

Fig. 3.83 Foundation-cutting

Fig. 3.84 Structural concrete cutting

vacuum system accomplishes with various hose diameter's (2″ to 10″) the flexibility to retrieve or keep free of water accumulations, small and difficult to reach interior locations, areas and cavities. The precise determination of vacuum hose size, hydro-blast and UHP equipment and/or tool necessities can only be established when the structures aggregate size (rock and rubble) and the physical volume in their location are determined.

A contractor wishing to operate in an excavated, more than 4′ deep interior–exterior trench must also provide a qualified competent person continuously enforcing the OSHA regulation 29 CFR 1926 which monitors and correctly secures the trench location eliminating trench destabilization by heavy load, vibration, water saturation, faulty equipment, etc. Under no circumstance can water be allowed to seep into adjacent grounds. A multitude of secure trench stabilizing equipment and pasting techniques (tar, foam, rubber liners) are applied, supporting and covering the total interior cavity before a submersible pump is placed below the application area. The pump's discharge hose is connected to a

storage tank (roll-off box) which separates heavy debris and simultaneously discharges water to a water filtration and recycling unit. When concrete cutting applications are underway, tarpaulin procedures and a heavy steel plate will protect the surroundings from jet's directional impact and diffuse the high velocity water or water-abrasive jet to the bottom of the cavity. Whenever possible, direct abrasive jets velocity to the building's exterior and do not load abrasive garnet within the exterior cavity area. There is a variety of equipment available to affix concrete cutting gear to footers, and walls, as there is a variety of successful application criteria, where the shovel of a backhoe or bobcat is applied to securely mount and stabilize equipment. Most importantly, the nozzle standoff distance to a concrete surface should not exceed ½″. A standard cutting operation on a foundation reinforced with rebar measuring 2′ in width should produce a minimum cut of 6′–8′ linear feet per hour. Hydro-cutting precise squares into reinforced concrete slab-flooring can be achieved using a four-wheel cart mounted with jets angled at 15°. Jets are guided by a form or straight-edge in smooth repetitious movements. The depth of the cut should not exceed ¼″ below the rebar structure. Once the cut has been achieved, the process is finalized by impact hammer. Use caution, the jet must not break through the concrete base as this will result in subsoil tunneling. Ground-flooring and hydro-cutting procedures can be cumbersome (tunneling effects) when compared to diamond blade cutting methods. Some manufacturers claim superiority in this specific application. Physical circumstances surrounding water jet technology simply do not yet support such claims.

In spite of existing controversies, hydro-cutting plays an invaluable role when working within volatile environments such as refineries, explosives and weapons industries, mining, marine industries, or flour and coffee mills, etc. where development of heat, gases and sparks could be truly problematic. By nature, debris accumulations consist of water, abrasive garnet and fine structural material (hydro-abrasive cutting), generally resulting in a simple refuse recovery process versus the hydro-blast or UHP concrete demolition applications where aggregate rubble of various size demands an exacting removal criteria.

Starting in early 1970 the need to repair structural concrete facilitated the development of heavy concrete demolition, then identified as hydro-demolition. This in turn provided the technical parameters, psi–gpm requirements and calculations for various substrate removal and roughening procedures. In considering most technical variances for a nozzle configurations utilizing up to 600 hp pump-drive capacity; nozzle design, gpm–psi performance with varying stand-of distances to the rebar enforcements and beyond was established.

The steel cutting method is derived from earlier design technologies for bridge pylon cutting applications (1967) incorporating the ability to perform the cuts through their existing rebar structure simultaneously utilizing abrasive concrete cutting heads. This capability was introduced to construction sites where bridge expansions were deemed necessary and later on bridge piling where a base deterioration required repair.

Today, available hydro-tools enable us to cut concrete and rebar structures, or if desired, remove concrete only, exposing the cleaned rebar in a fully-anchored

position, creating no micro fractures within in the substrate's anchorage. Pylon cutting is achieved through the use of a concrete-cutting head, utilizing a water abrasive mixture at 10,000–36,000 psi, 8–38 gpm. Cutting head design and performance capabilities vary as to manufacturer's experience-ability and pump drives power range.

Depending on an encountered application the necessary garnet volume can range from 50 to 200 lb per hour. A copper slag grit of 1 mm works well. Colorado or California silica is usable and less expensive, but the actual cutting time could increase up to 30%. When utilizing ideal technical conditions, a heavily-reinforced 6′ Ø bridge-piling is cut within 2.5 h.

The industry supplies hydraulic or air-driven running gear featuring a metering device to control the forward drive similar to cutting tools applied in pipeline cutting or welding operations. Equipment manufacturer pending, the adjustable cutting speed can range 1′–20′ per hour. When choosing a unit, one must pay close attention to its attach-ability. Such units feature combinations of vacuum, chains and other mechanical devices to accommodate various application and fastening criteria. A well-designed abrasive water-jet will maintain its tight formation while cutting through reinforced concrete. Experienced operators adjust the forward cutting motion by recognizing the appearance of jet parting the channel. A diffused or partially diffused jet indicates the drive speed is too high and should be slowed to the point where diffusion appears minimal. If logistically possible, install the unit above the cut to be performed, thus minimizing soiling of unit's hydraulic-air drive-chains, sprockets and general running gear, etc.

Concrete removal applications are not so similar. The major difference being the absence of abrasive material and the accumulation of waste aggregate which requires effective removal, storage and transportation solutions. Aggregate size differs as to the specific concrete function–application resulting in variable technical application solutions encountered with every jobsite. Adding various physical surface variations, job location and ever-changing environmental prerequisites which include blast water recovery, filtration and recycling methods, the high-pressure water concrete demolition–rehabilitation criteria differs in:

- No deformation or damage to rebar structure or its anchorage (Fig. 3.85a, b)
- Rebar corrosion removal to desired standards achieved within the aggregate
- No structural vibration, impact or abrasion damages
- Total avoidance of developing micro fractures and fissures in substrate
- More clear-cut measurable-estimating decree for load classification within the demolition–restoration
- No dust development, correct application indifferent to aquatic environment
- Superior production times and gentler removal in comparison to all other methods.

Hydro-trigger gun operations are equally common for various concrete removal applications and are enhanced in today's utilization of UHP tooling and subsequent specific application techniques. When refurbishment is deemed necessary,

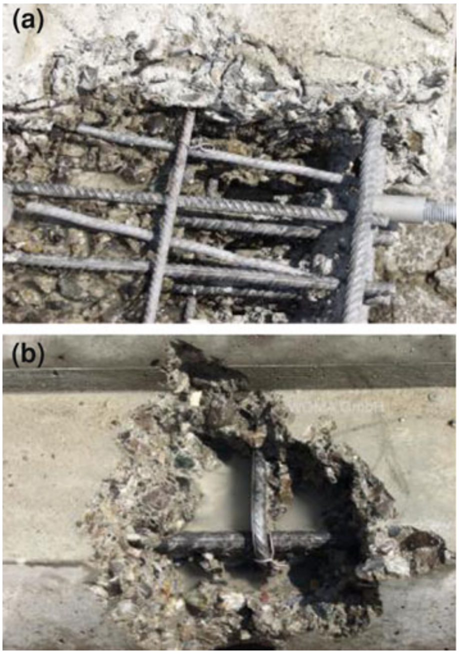


Fig. 3.85 **a**, **b** Corrosion free rebars

steel railings and failing railing fixtures buried in possibly stress-damaged concrete must be removed without further disturbing the surrounding aggregate. This is manually performed with a high-pressure trigger gun at 10,000 psi and no more than 8 gpm or a UHP trigger-gun applying 36,000 psi generating 3 gpm.

This effortless type of spot maintenance is of an advantage to general contractors when considering that concrete tear resistance is improved up to 80%, making this application ideal in difficult areas or on intricate concrete structures (Fig. 3.86). An adequate horsepower requirement, combined with sufficient accessories and tools will provide a dual gun capability found always advantageous when high volume workloads are anticipated.

Effectively splash guarding the procedures, controlling various traffic situations, removal of aggregate and fixtures from the jobsite, operating blast water recovery, filtration and recycling equipment can be a complex mission and must be in detail calculated and added to overall time and cost estimates, which are most always competitive and more importantly less costly to the contractor than previous job solutions and their methods. The industrial environment also requires mobile and stationary guidance systems effectively offsetting nozzle or nozzle carriers recoil forces with standard operating pressures ranging between 8,000 and 45,000 psi, and can vary from 55 to 1,200 horsepower configurations.

Overall, the in depth desired demolition capacity depends on adequate horsepower-input enabling a nozzle standoff distance to the concrete structure. In opposition the ultra-high-pressure (UHP) water-jet or turbo nozzle facilitates a controlled and quantifiable concrete removal application, working at comparatively

Fig. 3.86 Damage-corrosion free

Fig. 3.87 Concrete jet mill

minimal water volumes, equaling a limiting but precise standoff distance with substantial lesser horsepower inputs and trigger-gun recoil forces.

Apart from water volume applied, in required space (nozzle standoff distance); a repetitive nozzle fixation to surface–substrate-interface is of utmost importance. This is true for manual (body mechanics), automated and fixed mobile equipment operations, guaranteeing a precise and repetitive concrete milling procedure and, for this matter including constant and if necessary gentle surface cleaning methods will always establish their business superiority and application competitiveness (Fig. 3.87). This is especially obvious when competing for road, tunnel, and bridge maintenance contracts, where it is an indispensable application facet. In the last decade, surface cleaning, restoration and rehabilitation techniques developed and found to be superior, financially most competitive and outperforming prior parallel services and technologies in most areas.

Mobile equipment or better mobile and affixed nozzle carriers are the epitome of precise and repetitive performances, guaranteeing set nozzle standoff distances applying various horsepower inputs with varying forward, sideways and elevated–vertical–overhead milling capacities. Some of the available equipment is designed for multipurpose application varieties, including surface cleaning, coating removal, concrete surface roughening–profiling and demolition, or the cleaning, coating and corrosion removal on steel surfaces.

The construction industry is finally applying jet mills, which were designed decades ago and successfully tested in the field. General contractors found the hydro-method enhanced adhesion 70–80% while out-performing all other concrete removal techniques up to 70%. The process is dust-free and most importantly differentiates between deteriorating and damaged concrete, eliminating further operational mechanical influence, especially significant when concretes

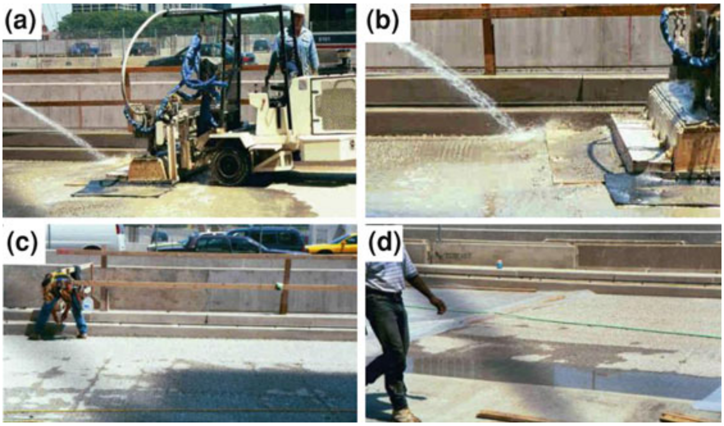


Fig. 3.88 **a**, **b**, **c**, **d** Scarifying concrete

compressive strength and integrity falls below 5,000 psi. Loosened material is swept up and removed by a standard street cleaning machine (vacuum-rotary brush). Finer particles are then flushed by fire-hose and introduced to a water recycling and filtration unit, resulting in ideal resurfacing conditions.

Bridge deck restorations require resurfacing of worn, deteriorated or cracked and/or blistered decks, and can include preparing the structures sidewalks, railings and buried fixtures. Generally the removal depth of such deteriorated surfaces is between ¼″ and ½″ but can vary to a 1½″ layer on older structures due to many past repair procedures. The required specification and at will manipulated surface roughness varies between job site and is subject to product specifications in the resurfacing phase.

This is today considered a straightforward application criterion and is most often performed with a mobile self contained unit. Operating pressure on a truck or tractor mounted traversing jet mill is between 10,000 and 43,000 psi at gpm performance required by traversing nozzle carrier design (Fig. 3.88a–d scarifying concrete).

Equipment square footage performance varies by design and horsepower input, and can be between 400 and 950 ft^2 per hour depending upon cover deterioration and depth performance requirements. Sidewalks and other confined, narrow or inaccessible areas are scarified using a manually operated jet mill in combination with hydro-blast or UHP trigger-gun operations. These units have the capability of scarifying or product removal within 2″ of the curb, preventing damage to insulation and maintaining the curb profile in its entirety. Manually operated units feature large pneumatic tires, allowing for a smooth roll-off performance and, in doing so, achieving a controlled nozzle standoff distance. This operation requires protective skirting procedures (mobile) within jet mill's and trigger-gun vicinity, keeping barricade costs to a minimum. The preparation of new concrete road decks (Fig. 3.86) by profiling a semi cured concrete substrate to a desired product

specification can require a close or sometimes stepped procedure between surface prep crew and company installing the required system. Often concrete's internal specified humidity must be maintained requiring moisture barrier procedures while in the profiling process. Temperature, curing, shrinkage and drying times of various product systems within a new installation procedure must be controlled. Maintaining a concrete's correct moisture content can also be of importance when repair or structural expansion procedures are undertaken.

To update or increase bridge load qualifications, contractors may be required to remove concrete aggregate below the second rebar structure on all load essential areas such as bridge decks and bridge heads. Once this is completed, rebar matting is added, gaining required tonnage. When the original pre-stress qualifications of a bridge are in jeopardy, mechanical removal methods (impact-hammer) have proven to be inadequate. Vibration deformation and expansion of rebar metal cannot be permitted. Light weight tractor-mounted deep scarifying units are readily available, operating at 20,000 psi, to 45 gpm, cutting to a depth of 4″ per passage, producing approximately 14 square yards per hour removal rate and cleaning simultaneously the rebar structure to S.A. 2.5, and in most instances eliminating final sandblast procedures. Most importantly, before, and while in a structural rehabilitation, expansion, or load increase process, a consistent assessment and fluid analysis, determining the repairs influences on the structural integrity within the demolition, repair and the final new product installation process must be at all times guaranteed. To do this it always includes the control and precise estimate of the additional weight introduced by the hydro-blast equipment and support equipment, shifting weight classification by tractor trailers loading concrete refuse, and considering the vacuum-trucks utilized to perform the final cleanup which are always exceedingly heavy due to concrete-water weight, possibly one-sided general traffic loads, and the loss of unforeseen or miscalculated weight-bearing integrity due to concrete removal, especially during times of possible seasonal frost, etc. This safety criterion demands a very close and effective relationship between subcontractors, contractors, engineering and department of transportation. Overall, when removing failed concrete by the hydro-demolition method (Fig. 3.88) an up to 75% savings in time, labor and equipment expenditures can be realized. Adhering to all OSHA safety regulations, stressing adequate scaffolding, tarp procedures effectively controlling water, concrete refuse flow, including barricades and traffic controls are all areas where added efficiency is realized.

When scarifying bridge heads and bridge side walls the various tractor-mounted units are equipped with an overhanging robotic and adjustable fixture accommodating a vertically-positioned jet mill. Utilizing this method eliminates the erection of scaffolding, but requires tarpaulin procedures to protect traffic and the employment of water recovery and recycling-filtration procedures. A removal performance criterion requires approximately 14,000 psi at 34 gpm producing a scarified area of 170′-linear 17″-width 10″-depth and is accomplished within three 8 h shifts.

Within this application field, cement wash, bituminous products, general paints and epoxies are often removed in specific areas with a, 15°–20° fan nozzle at

approximately 11,000 psi, at 6 gpm. Concrete will destruct at about 12,500 psi; 11,000 psi is the recommended applicable pressure. At this given psi–gpm performance, an area of approximately 300 ft^2 can be cleaned per hour. Suggested tool choices for this application are hydro trigger-guns, turbo or spin jets and jet cars. With these available tool configurations, applied wet and dry abrasive blast methods removing contaminants-products or to prep a concrete surface (profiling) becomes obsolete. The low-fluid volume, high pressure system configuration delivering its velocity by means of a qualified fan jet will not attack a concrete substrate surface but allows an absolute cleaning method in porous depth. Hardened epoxy coatings often lack strong adhesion to a concrete base. Spin jets, jet cars and turbo jets are the ideal equipment for this job. With older structures, the possibility exists that concrete surfaces cannot withstand volume–pressure requirements to penetrate and remove acrylic products. In such circumstances, try a lower volume nozzle at 3 gpm and 11,000 psi. Again, to clean surface areas, spin jets and turbo nozzles at lower volume configurations are the most effective. If paint adhesion cannot be broken below the compressive tensile strength of a concrete–coating interface, the hydro-abrasive method may be a gentler procedure.

Protecting interior and exterior concrete surfaces in various industrial environments is a common prerequisite. When applying today’s modern coating systems it requires a proper surface preparation, providing proper coating adhesion. Up to 80% of all coating failures are due to inadequate surface preparation and cleanliness. A service provider specializing in and delivering an ideal surface condition is well advised to be aware of customers future intentions for the surfaces he treats. When a following coating procedure is concluded and premature coating failure occurs his past services will be the first to be investigated. Appropriately recording the applied job specifications and results are important, as is maintaining the results in an orderly fashion to be recalled at any time. The best defense is to educate a customer as to the merits of a correct coating application. Work should not be performed on rainy or foggy days and temperatures below 50°F if not otherwise specified. Concrete structure has cured at least 30 days at material temperatures of 75°F plus, and a surface pH value should be between six and eight. Concrete must be free of moisture, meaning that concrete seldom drops below 15% in its structure. Past concrete enhancement or treatment such as hardeners, sealers, form-release agents, curing compounds must be compatible with coatings or removed. This removal process is a hydro-blast job description.

Identify and provide coating manufacturer’s surface profile requirement for best results. Apply various test patches and perform pull-off tests. Given the nature of widely differing concrete surface appearances and unknown conditions such as deep-seated contamination, chemical imbalance, friability, roughness, porosity and unidentified permeability can be principally limiting to coating performances in adverse conditions, as well concrete surface applications and high-pressure-water tooling will vary substantially. Competitors within the field will utilize milling equipment (cutting teeth on rotating drum), flame blasting, needle gun equipment, scarifying with rotating disc, shot-blasting and vacuum recovery, acid etching and steam cleaning, or wet and dry abrasive blasting also with vacuum recovery.

GEAR - LIST AUTHORIZATION

Concrete cutting, scarifying, surface preparation, demolition and restoration

Customer & Company: Web site: e-mail:	Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:

Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:

Job Description:		
Job Location:	Job Site Risk Assessment:	Specify: ©
Job Review Performed by:		

Blistered bridge decks: Bridge heads: Bridge pylons: Foundation-footer: Stress damaged building: Brick building: Concrete flooring: Cured epoxy:	Other:	Parking lots: Intersections: Sidewalks: Steel railings: Railing fixtures: Concrete slabs: Building facades: Other:
Overall cutting depth and width: Overall material volume to be removed:		Overall square footage to be serviced: Other:
Existing structural damages: (explain)		Safety procedures: (explain)
Spot demolition: Spot scarifying: Spot cleaning: Blast water available: Blast water dischargeable:		Acid treatment: MSDS: Acid neutralization: Confined space: Surface pH: Other:

Equipment: Jet car, spin jets, turbo nozzle, jet mills, deep scarifying unit, whirl disk:	
Ultra high-pressure pump: psi-gpm Hydro-demolition equipment: psi-gpm Concrete cutting head: Abrasive cutting head: UHP, trigger-gun-nozzle: Hydraulic air gear assembly: Magnet-vacuum base assembly: Vacuum-jet-recovery:	Roll Off-Box: (Water tight) Roll Off-Box: (Vacuum) Water filtration and recycling: Vacuum truck: (CFM? Mercury?) Steel plate: (Specify Size) Abrasives: (lbs) Specify grid size: ? Barricades: Protective skirting: Surface profile-roughness gauge Flash rust inhibitor: Rust converter:

Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.:			
Environment:	Industrial	Commercial	Residential

Today each and every one method has disadvantages to a high-pressure water application, especially in the area of cleanliness, treating fungus, molds and dissolving or removal in depth of soluble contaminants.

Environmentally producing the smallest footprint with least of all possible air contamination, safest application performance in most volatile industrial and marine environments, no impact, spark-flame-heat or mechanical shock

development, and most often a surface friendlier product removal procedure within a tremendous time savings criterion are hydro-blast application advantages. The fundamentals of surface preparation, cleaning and coating-concrete are well explained in publications offered and provided by SSPC the society for protective coatings.

3.7 Wet–Dry Vacuum Applications, Dredging, Emulsifying Sludge, Gravel Cleaning, Dust-Refuse or Bio-product Loading, Transfer or Removal of Industrial Product, Hydro-excavation, Pumping Fluids

Waste product disposal and/or product–material recovery by utilizing the non-destructive, cold and spark free vacuum technology which includes transferring volatile-flammable products in unpredictable areas and confined spaces is an expertise developed for sewer cleaning and sewer waste recovery by WOMA corp. 1958 (Fig. 3.89). The equipment is powered by a straight-thru or ring-jet vacuum pump producing commercial and/or industrial performance, operating between 18 and 600 hp.

This robust application variety, ease of vacuum hose manipulation, diversity of accessories and jobsite accessibility is this equipment's obvious advantage. Superior material transfer capability in height and distance, equipment limited volume and weight, providing an unmatched disaster clean-up potential due to power and water source indifference especially when combined with a water filtration–recycling capability and the constant transfer of static electricity, which is so menacing to the industrial vacuum truck industry, etc. are further motivating facts to utilize a hydro-vac wet–dry mod system.

Comparable in operational intent and basic technical function to the common shop-vac or, if so desired, to the high-capacity industrial vacuum truck (Fig. 3.90). Their major difference lies in a lesser application versatility and subsequent variety.

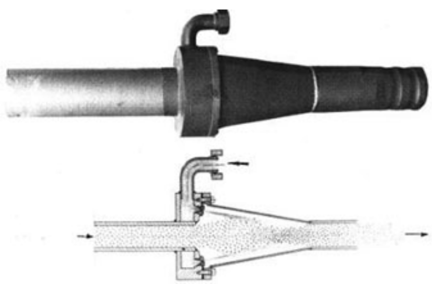
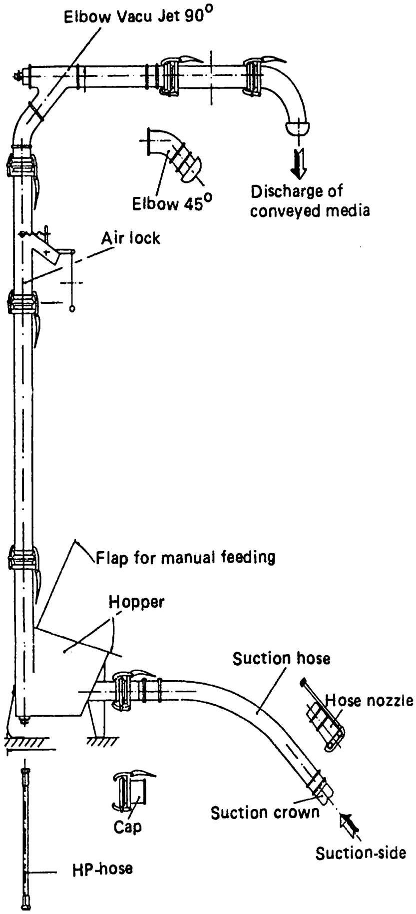


Fig. 3.89 Ring-jet vacuum pump

Fig. 3.90 Industrial product transfer system



The Hydro-trenching, excavation of buried infrastructure, pot-holing for fence and utility poles and the directional drilling of test holes etc. has found its market by utilizing industrial vacuum trucks hydraulically manipulated hose-pipe boom assembly which incorporates the high-pressure water nozzle fixture, enhancing soil breakup and flow characteristics as previously performed with various sewer cleaning equipment. The absence of static electricity and physical damage by excavating equipment to concealed gas, water, fiber optic, electrical general utility infrastructures, vulnerable especially when space, size and ground restrictions are present is circumvented (Fig. 3.91). Hydro-trenching is safer and more cost effective than operating mechanical excavation machinery or manual digging procedures. Trenching can be dramatically enhanced when supported by 3/8″ hydro-lance assembly utilizing round jet or turbo nozzle equipment up to 2,500 psi 2.5 to 5 gpm. Various hydro-tools can greatly support a controlled soil removal capacity when trenching.

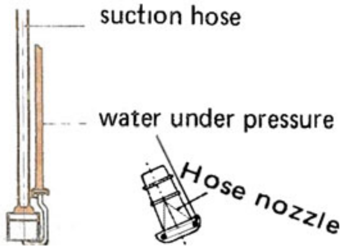


Fig. 3.91 **a**, **b** Hydro-trenching vacu-crown

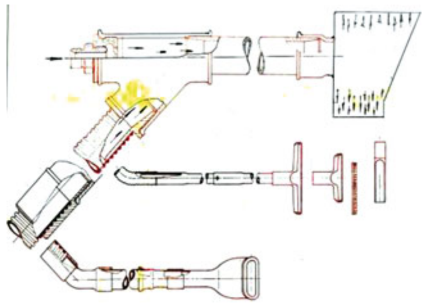


Fig. 3.92 Jet-pump, product separator-tooling

A site related qualified pre-job meeting considering possible site restrictions and permits, pedestrian and vehicle safety, possible overhead–underground danger (electricity-buildings, etc.), qualified shoring of trenched structure, soil conditions, dewatered soil dump site and procedures, adequate water management, recording of soil removal productivity and the signing of the pre-job meeting as well as the signing of the tailgate meeting paperwork are all basic job necessities.

Jet-pumps are utilized as high velocity liquid transfer pumps, high volume solids-product transfer-loading equipment, and as a vacuum compressor energizing a vacuum roll-off box container providing wet or dry mode functions incorporating product separation and air filtration for the pump air intake. All three methods differ only in placement of jet-pump job location, horsepower input, vacuum performance and subsequent creation of airflow-volume throughout a rigid-mobile pipe or hose assembly.

The shop-vac utilizes an electric energized fan-impeller to create its vacuum, the power for commercial–industrial vacuum trucks is derived from an engine driven gear or fan blower, whereas the hydro-vac wet–dry system develops its power via the jet vacuum-pump.

Product separation, filtration in removing materials or products from the transporting airflow is described at best as similar. For instance, an 18 hp pressure washer will power its vacuum-pump, which in turn utilizes created air-vacuum energy to shop-vac like accessories (Fig. 3.92) and debris collection in a container. The 18 hp vacuum-jet systems differ only in physical size, being larger and sturdier. The main difference between them lies in application versatility, due to creation of max-vacuum and higher-airflow performances.

Fig. 3.93 **a**, **b** Tractor, vacu-roll-off box

The jet pumps ability to create near absolute vacuum independent of altitude (29 mercury or 10 m water column) subsequent high velocity air movement in hose assemblies, pipes and vacuum tanks prompted hydro-manufacturers and contractors to develop an array of material handling applications.

Some of the more common applications are sludge removal in digesters, dredging of settling ponds, fly-ash, talcum, refractory and coal dust removal in refineries, power plants, bunker-seed removal in ship and barge product holds.

The vast application variety requires differentiating and recognition of three applicable hydro-vac systems, including the performance capabilities of pressure washers at 18 hp and hydro-blast units from 25 to 600 hp.

Hydro-vac dry mode operations above 100 hp generally feature a cylindrical or square vacuum roll-off box (Fig. 3.93) situated stationary on-site (10–60 yard) or truck trailer mounted (roll off box) with a hydraulically operated dump-gate, liquid discharge valve and interior primary and secondary water-misting system controlling volatile atmospheres and can feature a simple secured explosion relief venting system.

Cyclone and configurations are found between the vacuum box and vacu-jets suction orifice, separating remaining airborne particles. When volatile products, areas and confined spaces are encountered the filtration unit can be placed and employed offsite or outside in safe distance connected to vacuum box by pipe-hose assembly only. The contamination by airborne particles of the vacu-jets drive water can further be prevented by utilizing a mobile air scrubber unit which in turn permits the reuse of water by the hydro-pump system. This added mechanical air scrubbing is crucial, especially when powder-like or flammable gaseous products are transferred.

Caution. Be aware of suspended dust-like products and/or their environment which may be highly flammable or explosive not only under normal operating conditions but especially as a secondary combustible dust emission source due to a primary minor explosion, earthquake, wind swept situation and/or manufacturing-equipment failure, producing a series of deflagrations or shock waves resulting in fugitive suspended dust fuels. Besides being accidental, these situations are more often found in industrial facilities which do not maintain a housekeeping program,

addressing periodically the cleaning of vertical and horizontal areas, such as on top of pipes, beams, ledges, production facilities, etc.

OSHA identifies the potential of six major combustible dust sources:

Agricultural product as egg white, milk powder, soy–wheat–wood flour, various starch and sugar powders.
Agricultural dust as in coffee, corn, cotton, potato, rice, grass dust, etc.
Carbonaceous dust as in charcoal, coal, coke, cellulose, soot, etc.
Chemical dust as in sulfur, sodium stearate-ascorbate, ascorbic acid, calcium stearate, etc.
Metal dust as in, aluminum, bronze, iron carbonyl, magnesium, zinc, etc.
Plastic dust as in, poly-ethylene, acryl-amide, epoxy resin, phenolic resin, urea–formaldehyde, etc.

In operation hydro-vac systems do not develop a volatile heat source and by nature continuously discharge static electricity generated while transporting products-dust throughout a vacuum system (friction). This does not mean that equipment must not be connected to an OSHA approved ground point guaranteeing a continuous grounding path on-site or in every unit identified by customer.

Continuously misting dust suspension and concentrations is achieved with low volume nozzle elements, strategically placed within a vacuum hose assembly, vacuum pickup tools, vacuum box-container and cyclone filtration unit. Employing this high velocity air moving vacuum equipment is especially effective in industries where the potential for combustible dust explosions and fires exist.

This includes industrial bag-house interiors, coal storage facilities and their conveyor tunnels, fossil fuel power plant equipment and storage, sawmill environment and storage, bakeries equipment and storage, grain handling equipment and silos, milk evaporation towers to mention a few, all belong to the hydro-dry-vac application palette. Application techniques, as always, will vary with adequate product specification, consistency and their location. When extensive horizontal and vertical vacuum hose distances are required, vacuum hose suction orifices are fitted with high-velocity air nozzles to accelerate the movement of the material and provide adequate air-product ratio. Always consider the necessity of respiratory devices. When an acceleration of product removal time is possible (materials permitting) a vacuum hose manifold is installed, adding yet another operator. An 8″ vacuum hose is then reduced to two 4″ hose ends, bearing their required accessories.

Wet mode applications represent pulling gravel, liquid, or moisture-saturated products through a vacuum hose into a vacuum box. Product introduced to the low-velocity area of a vacuum box forces adequate product separation from high velocity air, permitting the bypassing of cyclones, and more importantly, the bag-house assembly. This eliminates possible friction losses due to vapor saturation of filter cloth coverings.

Most hydro-vac systems feature a manually-operated slide for both dry and wet mode operations. If adding 3–15% drive water to materials being removed does not constitute a problem or challenges the job objective, the direct application of

the vacu-jet can be highly successful. The vacu-jets nozzle velocity is utilized to slurry product, in turn, producing an adequate product viscosity, enabling the operation of trash or transfer pumps and therefore increasing the possible product transfer distance.

Such product transfer processes are quite common, as are degassing sewers, tanks, and vessels. Gaseous air is water-doused and then transported through hoses and pipes to be released into a designated area or atmosphere. Vacuuming flammable liquids and powders is safely performed due to the constant dissipating of developing and potentially dangerous static electricity (friction).

Not only has the vacu-jet added application multitude to the power washing industry, it has also further enhanced existing applications. All jobs present their unique particulars. In operation, product behavior varies greatly throughout a vacuum hose, filtration and hauling system.

To implement an equipment layout procedure maximizing and establishing the conveying rate (tons/h), precise material information must be obtained from potential customers to identify following:

Material:	Bulk density: (lb/ft^3)	Viscosity:
Aerated:	Settled:	Caked:
Sieve-granular analysis: (specify size and specific weight)		Maximum moisture content: %
Does material easily absorb moisture from air:		Does material cause abrasion:
Does material easily absorb moisture from water:		Temperature of material:°F
Is material aggressive in regard to: Iron, steel, aluminum, natural rubber, other:		
Must special provisions be considered for toxicity, volatile or explosive atmosphere:		
Does material present any hazards to personnel:		
Is material free flowing:		Filtering and collection of dust:

The vacu-jets commercial usefulness starts with a minimum 18 hp pump drive. Necessary hp range is determined by job description, classifying product consistency (mass, dry or wet, viscosity, specific weight), vertical and horizontal distances the product must travel between pickup and discharge point. The integrated number of elbows, 45° and 90°, determining the transfer vessels feed by gravity or suction, and type of transfer vessel as tanker truck, railcar, vacuum roll-off box and location, considering indoor or outdoor application or both etc. Reviewing a hydro-vac operation one can refer to the interior vacuum hose diameter (∅) as the approximate reference point of pressure washer's hp range: 2″ ∅ is approx. 18 hp, 2.5″ ∅ approx. 35 hp, 4″ ∅ approx. 100 hp, 6″ ∅ approx. 180 hp, or 8″ ∅ approx. 300 hp.

Within any transfer process of sewage from a city digester it is important to realize that slow-moving sewage water tends to separate from its bulk material (snails-organics). If allowed, snails and other bulk materials cake or settle in areas where physical friction or static pressures reduce the materials velocity. To avoid caking or settling, bulk materials are constantly agitated by a low-volume, high-velocity rotary nozzle situated close to discharge cone of the digester. If a rotary nozzle cannot be adequately buried, or if free nozzle rotation cannot be guaranteed, a sewer cleaning nozzle (1×4, at 45° to 90°) affixed to a rigid lance can be forced down through the top entrance of the vessel, enhancing the product movement in the critical cone area. When movement toward the hydro suction orifice affixed to tanks discharge cone has stopped, a rigid lance operation may becomes necessary to achieve a slurry process converting sewage to flow.

Pump stations delivering digester sewage into drying beds sometimes fail, calling for a dual hydro-vac-trash pump operation. An in-line hydro-vac injector adequately destructs and accelerates sewage slurry to a degree that 6″ to 8″ ∅, high-volume trash pumps affixed in series to a drag line can deliver products up to 3,000′ away; this eliminates trucking and other expensive work modes. Product knowledge and product behavior in transfer processes must be understood and properly recorded. Anyone involved in this industry will testify that job circumstances and product parameters are so diversified that generalization as to a job bidding procedure is impossible. Prior to bidding, a physical inspection must be made possibly requiring a tank or confined space entry permit. Correctly identifying the product to be removed, its volume, adhesion and/or flow consistency, as well as considering the vessels structure will enable the contractor to submit a qualified bid.

It is sound practice to add ones own locks and markers to the customers valves and flanges situated on the vessels supply and discharge lines, in doing so, avoiding unauthorized operational changes.

If hot work (welding) is performed in the vicinity, make sure all pipes leading to and from the vessel are adequately vented and free of gases. Flash explosions have been numerous and are most commonly caused by people not connected with the contractors' staff. Spark-resistant pressure washers or hydro-blast units are required and force the use of diesel fuel driven units. Most hydro-manufacturers do not spark-proof their electrical systems, which is required when operating in flammable and volatile areas (refineries, chemical plants, etc.).

Applying acid-proof mastics (silicone) to battery poles (+ −) and all other open electrical connections is a must. Hydro-blast units or pressure washers operating in volatile areas are grounded to protect against the possible development of static electricity. A copper cable with a spike and clamp properly situated will provide ground conductivity. The grounding of machinery must be extended to hydro-vac pumps, hoses, venturi blowers and air compressors, in short, all machinery in use. While in operation, a fire/safety watch must be posted on tank entries or vessel manholes. To reduce contamination possibilities by traffic relating to a vessel especially following a crew's shift change, create a step in–out area for all involved. In the bidding process, consider the added cost of safety procedures and

necessary safety gear. Air monitoring devices such as draggers, gas meters, venturi air blowers and fans are important assets, as are air gear, face masks and standby emergency air units (egress systems). Top-entry harnesses, belts, ropes, low-voltage explosion-proof lighting, lots of fire extinguishers (situated by machinery and manholes), steel-toed boots, extra rain gear, duct tape, rubber gloves, and ear protection are major expenditures. Further costs can be accrued in the categorization and hazardous recognition of a product. The distances to hazardous dump sites, transportation permits, adequate quantity of licensed dump trucks, dump site fees, and taxes should not be overlooked.

Consider the hydro dry-vac method a natural. Under load, gear blower-operated trucks can and will create tremendous heat on gear surface area and muffler exhaust systems (units built prior to 1990), creating a fire hazard when oil products or flammable vapors are present in the vacuum box. Furthermore, heavy, gooey products tend to cake in vacuum hoses creating a slowdown of the necessary airflow, subsequently reducing product movement. This effect, combined with a 60% maximum vacuum performance on gear blower-operated vacuum trucks, causes a slowdown in product movement (prior to 1990). In comparison, the vacu-jet pump operates under load at a 95% constant vacuum (close to the theoretical limit), therefore developing a much higher air velocity in vacuum hoses when products cake or present a high-viscosity factor.

Oil and fuel tanks, 150′–300′ in diameter (Ø) may feature steam coils affixed to the floorboard or ceiling float mechanisms, hampering the operators free movement and as such, complicate cleaning efforts.

Squeegees are practical tools in efforts to move the product to the vacuum hose orifice, which preferably is situated at the lowest area of the vessel. Caked, sticky products that adhere to tank bottoms and walls may be jetted off and slurred. Most flammable vapors are rendered harmless when doused and cooled while passing through the jet pumps water cylinder. When applying light oils or diesel fuel as a blast medium, oil, tar and bunker seed products are returned to the production process. Hydro trigger-guns with a lance extension incorporating fan nozzles at a maximum of 1500 psi operating pressure are sufficient to remove and slurry the most stubborn petroleum bulk materials. If diesel fuel is used, try to keep the nozzles submerged in the product, limiting fuel atomization. Generally, pump packing will soften with the extended use of diesel fuel and should be exchanged before a high-pressure water cleaning application is performed. Converting piston pumps to this type of operation requires technical safety procedures, which includes installing adequate pressure regulators and safety valves, engine rpm control to guard against over pressurization, etc. To avoid unnecessary friction loss in vacuum hoses, the truck vacuum box should be as close to the work area as possible. A low-volume nozzle attached to a vacuum hose orifice, which in operation meters minute amounts of fuel to waste-airflow, lessens friction between the product and the vacuum hose liner. Corrugated low-cost vacuum hoses, most commonly applied by contractors, have their advantages in that they offer higher flexibility, lighter weight, and lower cost; however, their inherent and excessive friction losses render them useless in this application.

The mere presence of a vacu-jet pump on the job site will promote a subconscious effort by the labor force to apply the unit whenever possible, stimulating the further development of applications.

When hydro-blasting, water and scaled materials can accumulate in the bottom of industrial vessels in particular when outgoing or incoming lines are situated below the water runoff point when, as for instance, the accumulated scaled materials in refinery tower tray cleaning applications are performed which can hamper the final cleanup procedure. Under these circumstances, employ a 2″ or 3″ vacuum hose, incorporating a vacu-jet within the available Hp range. The discharge hose is situated at an area where the accumulated blast water may freely separate from the scaled materials. Very often, materials are so minute or physically diminished that the vacu-jets discharge medium is directly delivered by sewer system to the sewage treatment plant. The hydro-vac pump also provides enough velocity to create a fluid drag sufficient to transport suspended materials through a sewer system.

As cooling towers accumulate vast amounts of lime and silt sedimentation in their low-velocity areas, a 38 gpm vacu-jet can directly slurry and move the product into the operating high-velocity channel (6,500 psi at 98% vacuum-efficiency). In this case, disconnect discharge hose from the hydro-vac pump and submerge the pump directly into the main water channel (fasten). This will result in the acceleration of the channels overall water velocity, enhancing further movement. A 4″ ∅ 150′ smooth suction hose will reach all low-velocity sections of a cooling tower. The cooling towers water velocity will transport most of the bulk materials to settling ponds, thus eliminating the excessive cleaning cost when general plant-tower shutdowns are imminent. Always start cleaning procedures on the towers' water discharge side; this eliminates the possible slowdown of loosened materials by existing product obstructions, therefore keeping the overall water velocity at its highest possible level. Safety procedures should be concentrated to the adequate use of protective clothing. Excessive contact to lime will result in skin irritation (diluted lime as well). The vacuum hose operator should never enter the unit without a safety harness and secured lanyard. He must be physically and optically controlled by a safety man situated in the towers entrance, who is, at all times, in visual contact with the hydro-units operator. The tower's water velocity is regulated and therefore, provides manageable working conditions. To harness recoil forces always fasten the vacu-jet securely. If company safety procedures permit, emergency communication can be established via an air horn (overpowering sound levels of air props and hydro-blast units). Cleaning scrubber tanks, autoclaves and grinders, large rocklike formations must be broken down. A hydro-blast trigger-gun with a 5′ rigid seamless stainless steel extension lance, bearing a straight jetting nozzle is utilized to effectively break refuse accommodating interior diameter of a vacuum hose in use, thus allowing the material to pass to an open dump box (8,000 psi +).

By adding a velocity diffuser box to the vacu-jet pumps discharge barrel the delivered material is further demolished by the subsequent impact on the diffuser

plate (up to 300 ft/s). This practice permits the loading of open watertight dump trucks fitted with a water overflow valve.

After loading is completed the remaining excess water is pulled to the material surface, avoiding sloshing due to truck operation. Specific weights of the materials being transferred must be heavier than water and preferably non-solidifying, keeping discharged water contamination to a minimum. When standard vacuum trucks are not available, the diffuser box most definitely enhances contractors application capabilities.

When sewer–pipe cleaning applications are performed, culverts, sumps, catch basins are designed and intended to become sewage traps (Fig. 3.94). To remove trapped sewage debris the preferred equipment includes a waterproof dump truck incorporating a vacu-jet pump (optional diffuser-box), and baffled discharge pipe-valve assembly for the removal of excess water and a hydro-blast unit in tandem responsible for the actual sewer cleaning process. Industrial contractors with equipment can enter the pipe and sewer cleaning business utilizing the reduced operating cost especially when the materials collected are generally minute in volume. To accommodate movement of large debris it is important to apply a 29′ lift capacity operating a vacu-jet pump and a 6′ vacuum hose assembly. Contractors performing this application repetitively may also consider purchase of a vacuum roll-off box designed to incorporate the dry–wet mode hydro-vac method, further enlarging their application capability. This should especially be of interest when adequate hydro-blast units are already in service.

Industrial service companies, their owners and managers must come to the realization that the hydro-vac systems capability will soon or later generate enough capital to permit a purchase of the most advanced industrial vacuum truck equipment; expanding the application variety.

Dredging accumulated sedimentation from ponds, settling ponds and neutralizing basins (Fig. 3.95), an application found in fossil fuel power plants, coal-washing units, cement plants, railroad yards, fish hatcheries, etc., can enlarge a contractors palette while avoiding financial expenditures. The necessary mechanical gear in question is either a hydro-vac dump truck wet mode system or a vacu-jet pump, which can also be affixed to a nearby slurry-collection tank or pump station.

The slurry-collection tank may be incorporated with a hydraulic or air-driven submersible sludge pump, which further transports sedimentation to any given disposal site or necessary drying bed. The work method to be employed depends on the vertical and horizontal conveying distances, where the vertical distance is measured from the water-sludge surface level to the top inlet of dump truck or vacuum roll off box and/or a pump station transfer vessel-tank.

All horizontal vacuum hose layout distances are measured from the suction orifice of the vacuum hose-dragline, including the vertical rise from the pond base to the water-sludge surface, where a flotation unit with an elbow from vertical to the horizontal is located. Product viscosity, specific weight, purity, product adhesion and bulk density factors will more or less determine the necessary removal and transfer time.

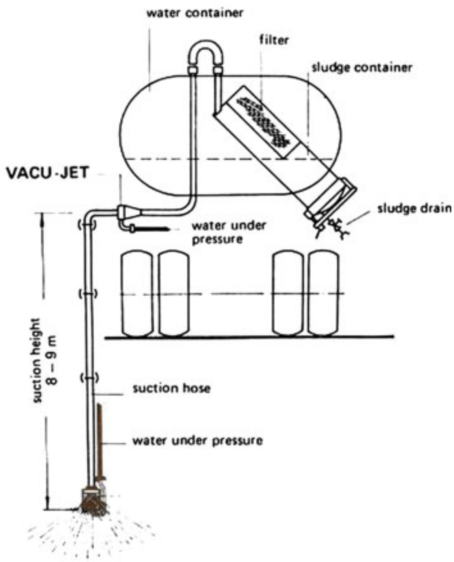


Fig. 3.94 Truck mounted Hydro-vac system

Bulk fly-ash and suspended lime products located below the water in visual distance (up to 50′) can quickly be removed by operating a manually-controlled flotation device. The control of suction hose depth adjusted, ropes are utilized to move systematically and in grid fashion the flotation assembly over the pond base.

The buoyancy of the flotation unit must be above 900 lb when operating a 4′ ∅ plus suction hose preventing excessive bobbing motion. A constant product movement and greater product flow is achieved by adding a circular plate to the suction orifice, beneficial when the product appears to be thin-layered or tends to adhere to the pond base. Suction plate adhesion to the pond base is avoided by adding high-velocity water channels, intended to attack harder mud formations within the center of the suction orifice. Clogging induced by debris such as sagebrush, rags, tin cans, wood, etc., is avoided by screening. The screen must be, at minimum, four times larger in surface area than that of the hose diameter; the screen mesh, however, must be slightly smaller. For instance, a 4′ ∅ suction hose orifice must be fitted with a 16′ screen and a 3 ½′ mesh. When blockage occurs, switch the injector to the off position, permitting the existing water-material column in the vacuum hose to back-flush, thus forcing the debris off the filter screen. In general, sediments are somewhat suspended due to specific weight and water saturation factor, prompting the start of a dredging operation at the deepest point of the pond.

An avalanche-like product motion, enhanced by the negative water pressure developing around the suction orifice, is a dredging characteristic. At this point of operation, the suction hose affixed to a flotation unit is moved, as required, in the direction of flowing material. Common industrial pond sizes allow a simple

UTAH POWER & LIGHT
Huntington, Utah

JOB DESCRIPTION

Sludge removal from Settling Pond at Utah Power & Light

EQUIPMENT

Hydroblaster: 4,000 PSI - 30 GPM
Hose: 1/2" x 100'
Nozzle: Water pump
Saction Hose: 3" x 200' maximum
4" x 200' maximum
Chest Waders: 1 pair

JOB PROCEDURE

Install injector and pipe in truck box. Suspend suction rope in pond using a floatation device. Remove visual sludge to a level below surface of pond.

Slurry in pond varies in density and viscosity. It requires constant attention to achieve proper viscosity for optimum flow-rate.

If material is too dry, then water should be mixed with material to achieve maximum flow rate in hose. Incorrect application will result in slower loading time.

Material is pumped into units at edge of pond. Mixture of clay and fly ash is used at bottom of truck box to insure no leakage in box during transport. Material is pumped to a level of 3-4 feet below top of boards in truck bed. Three (3) 30-yard capacity boxes are loaded during one hour of pumping.

SAFETY REQUIREMENTS

Standard plant safety requirements are in effect.

Fig. 3.95 Job-report, fossil fueled power plant

three-man operation. The major importance lies in the systematic movement of the suction hose throughout the pond area. A one-man vessel-flotation device following a grid outline, established by ropes, enhances control in murky waters. On a further note, this method of dredging outperforms other practices in price, time and labor intensity.

Ponds or settling basins often feature thin-layered liners constructed of asphalt, clay, concrete, or rubber. Products turned solid, due to operational oversight, evaporation or chemical reaction cannot be removed by the conventional method which employs bag-hose, caterpillars or the like. Damage to the liner is avoided by the use of the high-velocity, low-volume slurry method. Slurry nozzles come in many variations and operate between 500 and 5,000 psi at 4–40 gpm.

The slurry product is best removed with a ring-vacuum injector, either operating a vacuum box, wet or dry mode (Fig. 3.96), or placed on an open dump truck. To avoid the possibility of caking, product and physical behavior patterns, especially when products are transported by a vessel, must be tested for viscosity and setup times before (Fig. 3.97) high volume removal calculations are performed.

LIME POND

Hydroblast Report: Utah Power and Light
: Huntington, Utah
July 21, 1980

1. DESCRIPTION:
Remove approximately 350 cubic yards of solid lime from asphalt lined scrubber holding pond. Material is collected in pond measuring 200 feet x 60 - 80 feet x 6 feet, sloping to a drain at one end.

2. LOCATION:
Holding Pond, northwest perimeter, Deer Creek facility.

3. MATERIAL & EQUIPMENT:
A. 1 hydroblast pump
B. 2 tank trucks (local contractor)
C. 4 inch hydrovac injector
D. 3 inch hydrovac injector
E. 300 feet of 3 inch flexible vacuum hose
F. 300 feet of 4 inch flexible vacuum hose
G. 500 feet of 1½ inch fire hose
H. 12 feet of 6 inch aluminum pipe + ELBOW
I. 2 each 8 feet - 3/8 inches S/S #80 lances
J. 2 each ½ inch sewer nozzle with 6 equidistant .8mm side orafices with 1 forward jet of 1.2mm
K. 12 Aeroquip quick couplers
L. 300 feet ½ inch hydroblast hose
M. 4 each 3 inch and 4 inch vacuum hose nipples
N. 12 feet scaffolding (plant supplied)
O. 2 each lighting units (plant supplied)

4. MANPOWER:
1 operater with 2 assistants per 12 hour shift

5. PROCEDURE:
The application technique for removal of solid lime involves three steps.
First, solid mass must be cut into sections and broken down into a thick liquid. This is done with the sewer cleaning nozzle on rigid lance at 4000 PSI. Care should be exercised to move quickly through the material using as little water as possible.
Second, the partially liquified lime is fed into the 4 inch injector which further reduces the lime to a very viscous liquid. It is essential to completely slurrify all material at this point.
Third, the slurrey is then fed to the 3 inch injector which is operated below the surface of the slurry. The 3 inch injector pupms the totally slurrified liquid into the tank trucks. The trucks can be run continuosly if there is enough material for the 3 inch injector.

6. PLANT CONTACT: Gale Chapman - Operators must work closely with outside supervisors on duty.

7. SAFETY:
In addition to normal safety procedures, all exposed areas must be protected from exposure to material. A face shield must be worn while manually slurrifying the material.

Fig. 3.96 Lime pond, job-report

When cleaning, scaling, and preserving oil lube systems utilized for the operation of H_2O compressors, main turbine bearings and blowers in refineries, power and steel plants, the vacu-jet method is incorporated; however, under a different applicable pretense. It has been found that the usual hot oil circulation and flushing

method applied by maintenance departments to rid oil lube systems of fine contamination, scale and debris is inadequate, in particular after system repairs are exercised (exchanging damaged bearings, pistons, sleeves, and filters).

In applying light oil as blast medium (heated turbine oil), the oil-jet impact and high-velocity maintained throughout the cleaning procedure by the oil jetting technique guarantees that the present scale and debris will not settle or remain in the system's low-velocity cavities. Available flex lances will accommodate most pipe radiuses. Older oil lube systems may require minor modifications to fully provide access to the pipe system.

The vacu-jet pump can be located at a distance providing vacuum power. The flex lance vacuum feed unit is bolted or clamped to all strategically located pipe flanges. Oil heating and vacuum container units including the oil filter component are kept in the immediate vicinity to access of the oil lube system, preventing unnecessary friction or temperature loss throughout. Necessary blast oils are generally supplied by the customer's maintenance department. The lighter the weight classification of the blast oil (turbine oil), the higher the possible operating pressure (up to 3,000 psi).

When flushing and cleaning open compressor gear-ends, lube oil storage tanks, filters, and containers, maintenance departments must research system failure, which is substantiated in collecting mechanical debris. It is a nice gesture to collect and identify materials and, if possible, identify their locations. One will find bearing parts, aluminum, brass, and metal shavings, gaskets, and filter materials. With these efforts, maintenance engineers will be able to conclude their findings more precisely. When cleaning, some materials will fully suspend, especially when high-viscous turbine oil grades are employed. Positions and general locations of cavities, gears, sumps, bearing housings, and oil discharge-intake orifices must be located and cleaned. The ¼″ flex lance with a $6 \times .039 \times 45°$ nozzle guided and secured in its travel by a ¾″, 6-ft schedule 80 aluminum tube, incorporated with a radius sufficient to fully reach (in its flex lance extension) the total cavity area will do the job. Maintain a handful of flex lance tubes with a variety of radiuses and a selection of ¼″ straight jetting lances (3′–6′) with quick couplers accommodating a selection of T-pipe fittings with adequate nozzles as they will be necessary to reach all areas. Always start from the top of a unit proceeding downward, including the final wipe-down. The standard spraying characteristic of a water-jet fan nozzle is lost and appears defective when pumping light oil through them; however, they still provide better area coverage than round-jets (hard-hitters). While working above large compressors, tanks, or pipe assemblies, oil overspray is probable. To avoid injury by falling or slipping, concentrate on good footing procedures. When reusing blast oils, hydro-blast units produced low fluid volume is of an advantage to the high volume hot oil flushing procedure as a much smaller oil filter capacity is required. Filter surface area and size (generally 3–5 μm) solely depends on required volume per minute, oil viscosity, weight, debris concentrations and temperature. Customer maintenance department or operations handbook will provide oil fluid specifications standard to the cleaning procedure. Pricing in this application may be determined by

competitor's high-volume flushing operations, translating to approximately three times the hourly hydro-blast rate, which includes two operators.

Higher corrosion factors, synonymous with steel piping, require water, preferably demineralized, as a blast medium. Working pressures up to 10,000 psi may be necessary. After the scaling procedure has been completed, the vacu-jet system is applied to rid the system of all water pockets and vapor. Once this is complete, the pipe interior is preserved with an oil film applied by the flex lance, eliminating further corrosion possibilities until the unit resumes its' services.

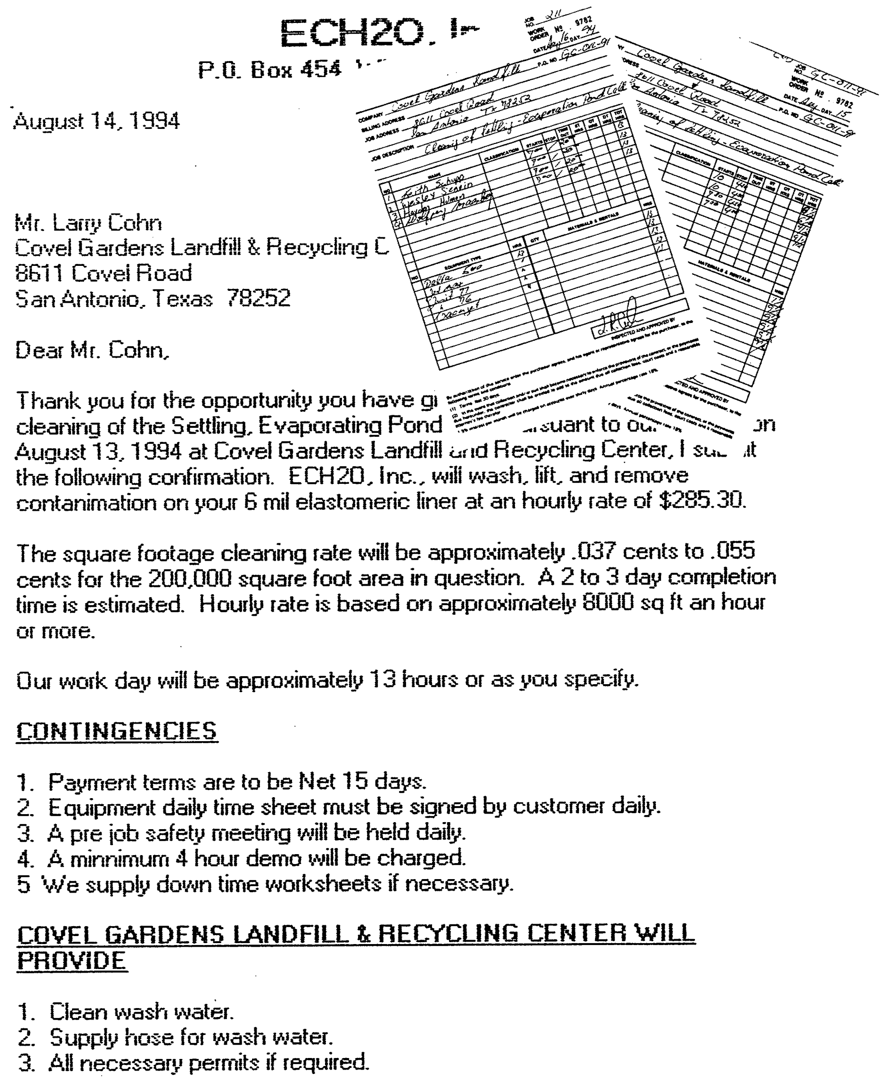
Bacteria removal and general cleaning of rock and gravel formation in commercial fish and spawning waters is generally considered a dredging application. Water jets at ultra-high speeds form a constantly-moving semi-stationary liquid piston in barrel, creating in its motion density the necessary vacuum (air velocity) to transfer any conceivable substance at high speeds through its liquid formation, resulting in a tremendous cleaning effect by the jet impact, velocity, and turbulence.

This application is at its best when a correct rock and gravel separation from the contaminated and silted vacu-jet water is accomplished. This is achieved by creating an adequate water runoff situation to physically retain the cleaned rock material containing silt and turbid water.

Lake beds, rivers and container locations will determine the sites of the runoff areas which are situated so as to permit the easy return of the cleaned rock material to the original pickup site. The incorporated vacu-jet pump (minimum 4″ ∅) with a buffer box to protect the rocks from damage and permits a controlled gravel and rock relocation, preventing excessive water turbidity. Recoil forces are largely diminished by buffer box and therefore allow the semi-automated operation of a rope-controlled flotation vessel, thus placing the gravel and rock materials in the desired areas.

Faced with accumulated hot ashes in clinker grinder areas (found in fossil fueled boilers or hot furnace products), as well as industrial spills where hot burning ashes or liquids are in dire need of removal, the hydro vacu-jet pump is converted to a "killer" fire-fighter that in its path extinguishes, cools and douses products while relocating them to a secondary location. Hydro-vac injectors are only to be employed when hot or burning product is water compatible in its dry, wet or flame-combustible state. Any vacu-jet design is employable; however, all must feature heat-resistant corrugated flexible metal hose technology on their suction and discharge ports. Knowing that generalizations concerning this application may result in a volatile or explosive situation, is it suggested that questions are directed to qualified personal in specific field of product specialization.

Cold storage facilities and refrigerated work areas, found in food industries, may utilize a vacu-jet system that permits high-pressure water cleaning methods, yet contains and removes all waters and debris in its working path. A manually-operated vacu-brush retaining a 15° to 90° fan nozzle in its belly is applied in hard-to-reach areas. The mobile units are designed with the same principle in mind; they hermetically contain nozzle overspray and return debris to a sewer or hydro-vac container, thus challenging large floor plans with reasonably smooth



ECH2O. I
P.O. Box 454

August 14, 1994

Mr. Larry Cohn
Covel Gardens Landfill & Recycling C
8611 Covel Road
San Antonio, Texas 78252

Dear Mr. Cohn,

Thank you for the opportunity you have gi... cleaning of the Settling, Evaporating Pond ...suant to ou... on August 13, 1994 at Covel Gardens Landfill and Recycling Center, I su... t the following confirmation. ECH2O, Inc., will wash, lift, and remove contanimation on your 6 mil elastomeric liner at an hourly rate of $285.30.

The square footage cleaning rate will be approximately .037 cents to .055 cents for the 200,000 square foot area in question. A 2 to 3 day completion time is estimated. Hourly rate is based on approximately 8000 sq ft an hour or more.

Our work day will be approximately 13 hours or as you specify.

CONTINGENCIES

1. Payment terms are to be Net 15 days.
2. Equipment daily time sheet must be signed by customer daily.
3. A pre job safety meeting will be held daily.
4. A minnimum 4 hour demo will be charged.
5 We supply down time worksheets if necessary.

COVEL GARDENS LANDFILL & RECYCLING CENTER WILL PROVIDE

1. Clean wash water.
2. Supply hose for wash water.
3. All necessary permits if required.

Fig. 3.97 **a**, **b**, **c** Job, evaporation pond, labor time sheet

surface construction. Manufacturers offer various new designs and applicable units starting at 18 hp and can be gas or propane operated. All should feature a dependable chemical injection system which applies soaps, detergents, light acids and liquid disinfectants.

Resources. The primary national fire protection association (NFPA) regarding standards related to the hazard of fire and dust explosions, NFPA 654, from the manufacturing, processing and handling of combustible particulate solids, NFPA

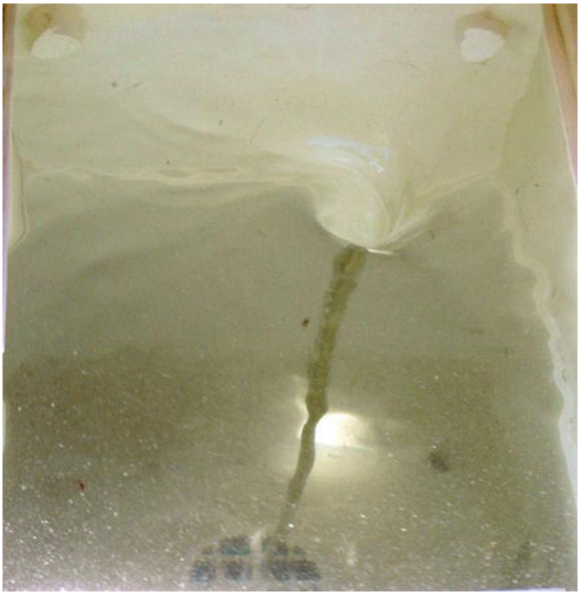


Fig. 3.98 Vortex formation in pump's water supply tank

61, prevention of fire and dust explosions in agricultural and food processing facilities, NFPA 484, standard for combustible metals, NFPA 664, standard for the prevention of fires and explosions in wood processing and woodworking facilities, NFPA 655, standard for the prevention of sulfur fires and explosions, http://www.nfpa.org

See the safety health information bulletin SHIB 07-31-2005, combustible dust in industry: preventing and mitigating the effects of fires and explosions, http://www.osha.gov

When designing a water and/or vacuum tank for a multi use application is it important to incorporate a possibility for various fluid draw capacities. Application or pumps varying performances pending, the interior design criterion is often insufficient, creating a possible vortex formation. This vortex formation (Figs. 3.97, 3.98) can be especially responsible for confusion when trying to solve or determine why high-pressure water hose assemblies excessively pulsate or can be responsible for either a slow and/or sometimes explosive piston pump failure. Havoc may also arise when product volume-flow estimates are inconsistent.

GEAR - LIST AUTHORIZATION

Dry-wet vacu applications, dredging and emulsifying sludge, gravel cleaning, product transfer

Customer & Company: Web site: e-mail:		Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Digesters: (city management) Digesters: Settling ponds: Tanks, vessels: (industrial) Tanks, vessels:(ships, barges) Bag-house: (industrial) Sewers: Drying beds: cooling towers: (industrial) Scrubber tanks: Autoclaves: Other:			Culverts: Sumps: Catch basins: Ponds, lakes: Neutralizing basins: Conveyer tunnels: Grain silos: Milk evaporating towers: Spawning tanks: Boilers: Cold storage facilities: Other:		

Product: Sludge: Fly-ash: Talcum: Coal dust: Cement dust: Others:	MSDS: Bunker-seed: Gravel: Liquids: Organic snails: Flammable vapors:	 Non-flammable vapors: Sticky products: Lime: Silt: Sewage: Others:	 Viscosity:

Tools: In-line air, water: Hydro-blast hose: (∅ and feet) Vacuum hose: (∅ and feet) Elbows: Vacu-Jet: (∅ 2, 4, 6, 8 inches) Hydro-unit: (horsepower?) High velocity spin-jet: (slurry) Sewer Cleaning Nozzle: (slurry-specify) Rigid lance: Vacuum brush: Vacuum truck:	45°	90°	Flotation device: Vacuum box: (yards?) Dry-wet mode: Specialized fire suppression system: Spark/ember detection for suppression activation: Open dump-box: Diffuser box: Stationary, in-line pump, tank: High volume trash pump: Tank entry permit: Air monitoring device: Others:		

Describe application and work procedure: Safety procedures:
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing Tel: e-mail	Engineering Tel: e-mail	Maintenance Tel: e-mail	Safety Tel: e-mail
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Plant hardware:			Hydro-blast equipment:		
Plant location:			Equipment: Expendables:		

Product Encountered:			
Hazardous Material:	MSDS:		Specify:

Describe application and work procedure:

Describe safety procedure:

Itemize equipment, safety gear, expendables, etc.:

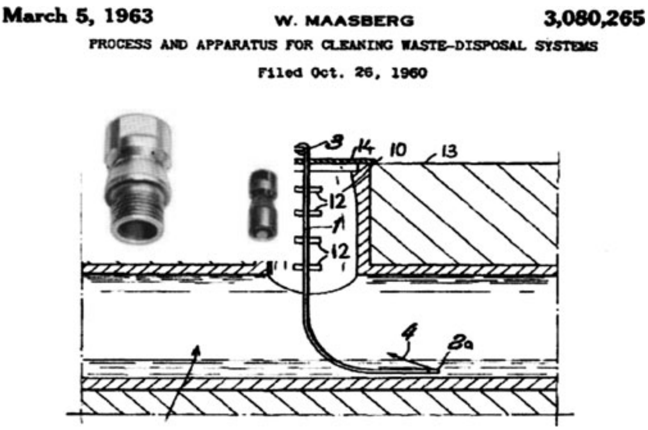


Fig. 3.99 1963 **a**, **b**, **c** US 1960 patent draft

3.8 Duct-Work, Canopy-Hood Installation Cleaning, Acid-Sanitary Treatment, Cleaning-Chemically Treating Pipe for Liner System Installation, Coating Interior (∅) Steel-Iron Pipe

The process of cleaning, chemically treating, or painting internal pipe surfaces ∅ (Fig. 3.99a–c), which include the interior duct surfaces of air conditioning systems, kitchen exhaust units, and general steel pipe-ducts, is an age-old application made possible with the development of pipe and sewer cleaning nozzles powered by water and/or compressed air. This application criterion eluded coating manufacturer and hydro-blast contractors alike (Fig. 3.100).

Today the necessary tool varieties such as tube–pipe–duct nozzle centralizers (Fig. 3.101) supporting interior cleaning, sanitary surface treatments or interior coating–painting applications after an acid and neutralizing procedure are readily available from various sources and manufacturers enhancing application capabilities. Remotely operated cameras and robotic transporters can be utilized in various support functions and are available on purchase or rental basis.

In the past, contractors, with a little self-help and ingenuity were able to utilize this application criterion successfully providing specific and specialized services. Nevertheless most interior pipe rehabilitation–restoration procedures are nowadays performed with vertical and lateral lining systems, which after installation may initially cure in place when forced onto the pipe wall by air pressure (6–12 psi).

The creation of a verifiable leak-free, in place, cured lateral pipe lining, especially within the mainline junction portion depends on factors that include the identification of pipe material, pipe wall contaminants and interior damage permitting possible groundwater infiltration, necessary access and interior pipe surface preparation techniques.

Fig. 3.100 1958 nozzle patent draft, Germany

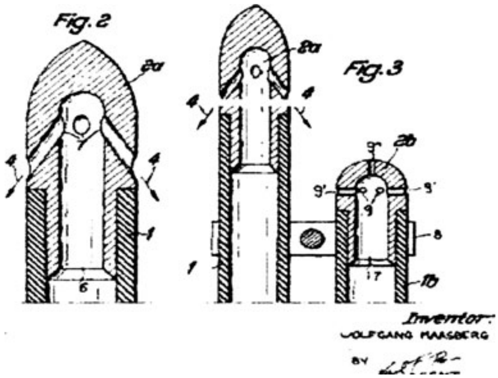


Fig. 3.101 Nozzle with tool centralizer

The performance or adhesive quality of resins applied to an interior pipe surface within a CIPP lining procedure depends on the correct identification of pipe substrate, cleanliness and surface roughness-anchor profile. This is quite simply achieved when clay, concrete or steel pipes are restored. The hot or cold hydro-blast or industrial pipe jetting application supported by various detergents necessary for typical grease and refuse accumulation removal and/or the utilization of various specialty sewer cleaning nozzles, including employing centered rotary nozzle carriers (Fig. 3.102) will quickly perform this requirement. Today PVC drain and sewer pipe systems feature various polyethylene-polyurethane film surfaces requiring a specific resin, which can be ISO polyester, vinyl-ester, silicate and epoxy to warrant adequate adhesion. In any case, the industrial pipe and sewer cleaning technique by hydro-blasting (hot–cold water) combined with today's available hydro-vac application diversity is the predominant tool combination for prepping duct, pipe and utility drain lines before a coating or lining-sleeve product can be installed. To understand this new application identity is it probably best to study similar application criteria and its performance technology.

Location: Boeing Aircraft Company
Building 4-01 Wing Heating Area
Washington, USA

Fig. 3.102 3D Nozzle-tool centralizer

Job Description: (Fig. 3.103)

Clean, remove rust scale, neutralize and paint concrete-lined sub-floor, steel duct system (4″ to 32″ ∅), a horizontal system with lateral side arms (app. 300′) supplying heated air throughout the aircraft wing paint shop.

The overall condition of the duct system had been such that during operation, rust and accumulated debris contaminated the general building environment to the extent that the installation of a new system seemed imminent. The present corrosion, in multiple layers, led to this opinion and therefore triggered a contractor's involvement. The contractor offered to remove rust buildup, acid treatment and neutralization of concrete and iron pipe, clean area, and paint coating procedures, plus guaranteeing a long-term solution with a written 12-month warranty (accepted).

Material and Equipment Requirements. 200′, 1½″ fire hose, 150 hp hydro-blast unit, 400′, ½″ hydro-blast hose, 6 × 1.5 mm ∅ pipe cleaning nozzle with cable ear, 30-yard vacuum tank truck with 4″ ∅ hydro-vac wet-mode system, 300′–4′ ∅ vacuum hose, airless paint spray unit (2,000 psi), 100′ airless paint hose, 180° airless paint nozzle, mobile paint nozzle carrier (centralizer), respirators, gloves, boots, rain gear, duct tape, four 1/8″ steel cables (100′ each), two cable ratchets, oxalic acid, sodium nitrate (rust inhibitor, neutralizer), tile-clad paint and primer.

Procedures. The steel duct installed within the concrete sub-flooring appeared very soiled and corroded. To remove all rust formations and debris throughout the system and to provide an ideal penetration dwell time for the oxalic acid (applied after cleaning), a pipe cleaning procedure utilizing the hydro-blast unit at 6,000 psi, 35 gpm combined with a 6 × 1.5 mm, 45° pipe cleaning nozzle was engaged. Simultaneously, the hydro-vac unit in play with a 4″ vacuum hose was placed in the duct system's lowest area to remove all arriving debris and water; in doing so back flushing into the system was prevented. Once rust formations were successfully removed, the duct system was completely saturated with oxalic acid over a 15-h period to provide ample dwell time. By adding oxalic acid to the hydro-blast unit suction tank, the 3,000 psi, 35 gpm nozzle velocities provided a great mechanical jetting impulse which reached all corners and cavities of the system. The following day, the employed hydro-vac unit removed the somewhat diluted acid within minutes, followed by a thorough pipe cleaning procedure

Wing Heating System

Hydroblast Report: Boeing Aircraft
Renton, Washington
September 4, 1980

1. DESCRIPTION:
Clean and coat two lines of sub-floor ducting system used for blowing warm air through the aircraft wing paint shop.

2. LOCATION:
Building #4-01, wing heating area.

3. MATERIAL & EQUIPMENT:
A. hydroblast pump
B. dump box on truck
C. 400 feet of ½ inch hydroblast hose
D. 200 feet of 1½ inch fire hose
E. airless paint sprayer @ 2700 PSI
F. one hundred feet of airless spray hose
G. 300 feet of 3 inch vacuum hose
H. 3 inches hydrovac unit
I. tile clod paint
J. tile clod primer
K. oxalic acid
L. nitrate nuetralizer
M. Detergent

4. MANPOWER:
1 operator with 2 assistants

5. PROCEDURE:
All areas of ducting must be thoroughly hydroblasted prior to painting. Using a sewer cleaning nozzle at 6,000 PSI, first clean the vents leading from the main duct and second, the main duct leading from the blower. (Some parts of the duct had not been in use for 15 years making it necessary to repeat passes with the hydroblasting nozzle to remove rust, caroded metal, paint containers, vermin, sand, rocks, and other debris). As water and debris are flushed out, the 3 inch hydrovac system is used to remove all waste to vacuum loader. After hydroblasting, Oxalic Acid is applied to all surfaces as a derusting agent. Then nitrate neutralizer is applied and duct the duct system is completely rinsed with clean water. Both the acid and nitrate are run through the pump and applied with the sewer cleaning nozzle at 3000 PSI.
When the system is completely dry, primer coat is applied by running the adjustable mobile nozzle carrier through the whole system. When the primer is dry, the final epoxy coat is sprayed throughout the system using the same mobile nozzle carrier.

6. PLANT CONTACT: Bob Harrison

7. SAFETY:
Standard plant safety plus extreme caution when working near aircraft

Fig. 3.103 Boeing aircraft, job description

removing all remaining acidity. At this point, steel cables were attached to the nozzle assembly and strategically placed to accommodate the upcoming paint procedure. Utilizing the self-propelling forces the nozzle and high-pressure hose assembly carried the steel cables throughout the pipe system which were detached in 85′ sections at every exhaust floor opening.

Before retracting the jetting hose-nozzle assembly, the cable ends were secured to a steel bar and suspended above to prevent their disappearance into the pipe system. To prevent rust film development during the drying process the jetting water carried a 3% sodium nitrate consistency. Overnight, the available air-heating unit transferred vast amounts of air (at 140°F.) throughout the duct assembly,

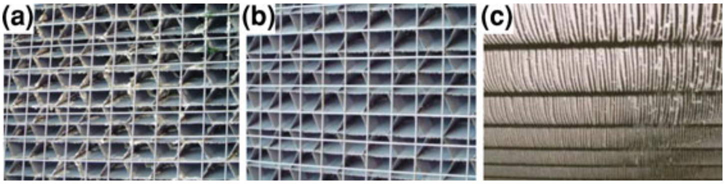


Fig. 3.104 **a**, **b**, **c** Evaporative

dissipating the remaining moisture content; the pipe system was left in a warm, ready-to-paint state. The paint procedure was started by applying primer throughout pipe system. The cable attached to the centered paint nozzle carrier enabled a smooth two-man operation. One operator was situated at the farthest floor opening pulling the paint nozzle carrier, affixed to the cable, towards his location. This facilitated the starting position of the paint procedure. The operator in control of the airless paint sprayer and its respective high-pressure paint hose then pulled the operating paint nozzle carrier toward his location. By passing three times, section by section, the primer application was completed.

Important. Before the drying process sets in, suspend cables in mid-air of duct systems ∅ by affixing a cable ratchet to a steel pipe centered across the opening of the floor surface tightening the cable to a point that contact to pipe wall is eliminated, avoiding adherence to drying paint surfaces. As a result of operating the wing heating system at 120°F, the adequate drying of the primer was guaranteed. Finally, three layers of paint were applied utilizing this technique. This elaborate pipe–duct system forced painting all lateral side arms first with a smaller three-pronged centered nozzle carrier before concentrating on the main air supply line. Nevertheless, this is a simple application and should therefore be vigorously considered by hydro or coating contractors, especially nowadays with ready available tooling.

Cleaning equipment applied, and various cleaning techniques for *HVAC* systems are a knockoff technology derived from the hydro-vac, and pipe sewer cleaning criteria. The technical components differ only in that the nozzle-hose propulsion and cleaning medium are compressed air combined with the utilization of high-capacity negative air machine systems producing various high velocity air capacities incorporating a high efficiency particulate separation (0.03 μm) and HEPA filtration technology with 99.97% efficiency.

Nevertheless the necessity to clean air duct systems differs substantially in that generally bulk material or waste products are not the and fin-fan cooler removal criteria. There are exceptions to the rule. Duct cleaning and mold remediation entails cleaning of various heating–cooling components of forced air systems. These components include the supply and return air ducts and registers, grills and diffusers. In commercial–industrial HVAC systems, boilers, heat-exchangers and chillers, heating and cooling coils, condensate drain pipes and drip pans, fan housing and evaporative coolers–cooling towers, etc. (Fig. 3.104) are applications of industrial nature.

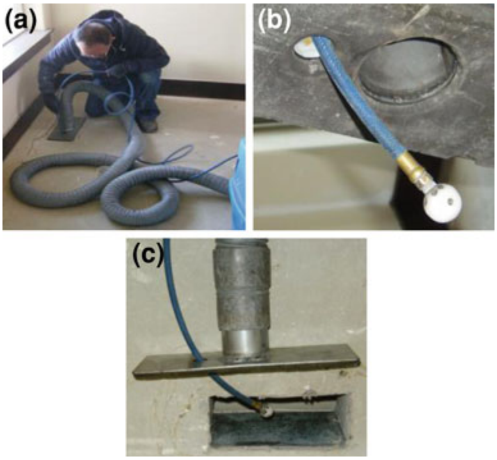


Fig. 3.105 **a**, **b**, **c** HVAC duct cleaning

Applications differ substantially in identification and classification as to the need of a remediation-cleaning procedure (Fig. 3.105). Most often the indoor air quality, high air humidity, mold, dust accumulation and pest infestation or a fire hazard are the common denominator, especially when air intake filtration requirements are not adequate. Also various environmental disasters, fire, storms and flooding or manufacturing processes can have accelerated adverse effects on air duct systems, requiring periodic cleaning intervals.

In office or commercial buildings such as airports, remediation is most often performed at night to minimize occupational disruption of tenants and customers, and minimizing potential contact to contaminants disturbed during an application processes. Also, before a mold remediation occurs the course of growth must be corrected before the cleaning or removal applications are initiated. Mold requires moisture for growth, which is introduced most often by excessive humidity, damage to the system itself and/or poor construction and can also be transferred from interior surroundings such as infected carpets, drywall, wood, dripping–leaking pipes, condensation, etc.

Residential and commercial contractor qualifications differ substantially as to training, licensing and utilization of equipment. Professionals can be categorized into four classifications:

1. Certified air system technician (ASCS) specialized in cleaning and restoration of commercial and industrial HVAC systems which includes servicing process exhaust and dust collectors systems.
2. Commercial and industrial ventilation system-mold remediation specialist (VSMR) offering certified hydro-mechanical, filtration and microbial remediation (CMRS) developed by the American indoor air quality council.
3. The industrial service provider for cleaning boilers, heat exchangers, condensers, chillers, cooling towers, bag-house units and various filtration equipment for modern industrial processes, where large quantities of airborne

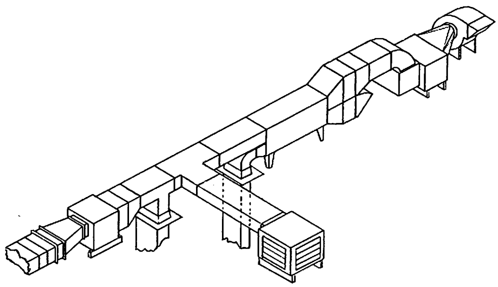


Fig. 3.106 Roof exhaust fan and duct structure

pollutants in various forms of particulate, gases, vapors, fumes, and mists are to be removed. Air streams can be toxic and in concentrations often exceeding safe level of exposure and can include the cleaning of plant production hardware in commercial–industrial HVAC environments. These air filtration systems most often operate above 25,000 acfm and will be designed to a staggering air volume requirement for specific manufacturing processes, as in cement plant, fossil fueled power plants, steel mills, waste incineration, bio-fuel plans, coal mills, ferroalloy production, etc.

4. Restaurant kitchen and cookery operations require a certified fire prevention hood and exhaust duct cleaning process which is a periodic undertaking especially where insurance, fire marshal-departments and law require quarterly or biannual cleaning intervals. Times are determined by high-volume cooking operations such as 24-h restaurant operations, charbroiling or chinese wok cooking where stubborn peanut oil residual presents the most difficult removal criteria, or a moderate volume cooking operation where duct system inspection requires a semi annual cleaning procedures. Smoke or grease laden vapors deposit their residue throughout hood and duct systems interior, including on the lateral duct roof structure (Fig. 3.106), where fans, draft diverters, and oil–grease collection systems must be cleaned to bare metal (NFPA 96, standard) and may include the cleaning of possible leak and runoff areas on roof surfaces. This also requires roof access and safety according to OSHA fall protection and safety procedures. Accessing a duct system can only be considered when a confined space entry procedure and its regulations are introduced. Safety concerns must be rigorous especially in regards to faulty electrical wiring, electrical lock-out procedures and identifying open drip-proof equipment not adequately sealed for steam or water jet contact. This does initiate a correct coverage-sealing procedure of all fixtures susceptible to moisture or water intrusion guided by international fire, mechanical code and OSHA regulation (electric socket, levers–switches–light fixtures, fan-motors, etc.). Preparation of interior kitchen services is critical as is the job walk to identify possible additional work, which can include grease traps and drains, floors, walls, ceilings, cold and refrigerated storage areas and production equipment. Equipment includes ovens, fryers, grills and storage racks, floor mats, etc. Identifying a possible added workload can drastically alter preparations and essential plastic covering (Fig. 3.107b) procedures.

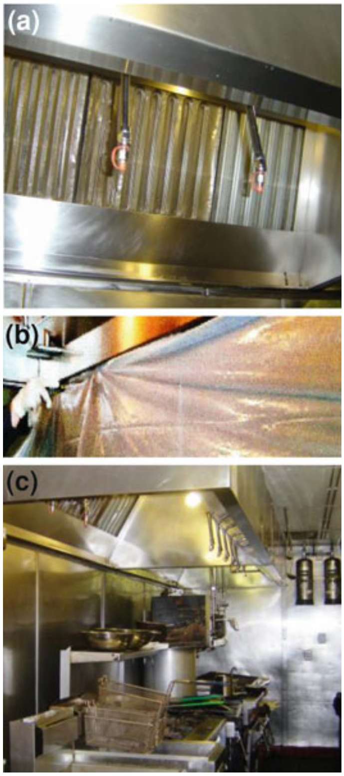


Fig. 3.107 **a**, **b**, **c** Essential plastic covering

A generalization for required tools are; FDA, EPA approved chemistry with MSDS sheet always posted on customer's premises, live microorganisms for grease traps, cardboard wedges, spatulas, continuous plastic sheeting 12.5′ by 200′ by 1.5–3 mil (rolls), duct tape, metal or plastic clamps, suction cups, short barrel trigger-gun, acid-alkaline foam nozzles, various extra short wand extensions offering quick couplers to trigger-gun and nozzle with a choice of 35° to 90° radiuses facilitating jet coverage on grease track channels and plenum areas, chemical resistant non-marking high temperature–pressure hose (3/8), centered high temperature Spin-Jets, and turbo-nozzles, various wastewater recovery and filtration equipment including the necessary vacuum hose and shoe fixture, roof access equipment and fall protection, warning signage as to cleaning activity, waterproof electric lighting, flashlight and personal protective gear.

Adjustable pressures may range from 500 to 4,000 psi at 2.5–5 gpm hot 200°F and cold water.

Developing a quick effective and straightforward strategy to capture created wash water within the cleaning process of filters, hoods and duct system is a contractor prerequisite. The goal is to avoid all contamination of surroundings. Applying water recycling-filtration and disposing of grease–waste products correctly will always be the dominating qualifying criteria. The installed plastic

Fig. 3.108 Hoods filter component's

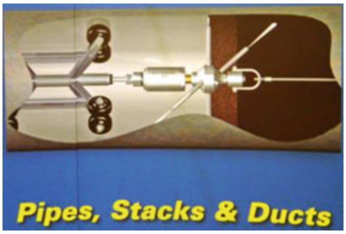


Fig. 3.109 Ducts 3D centralizer

protection sheeting must be able to withstand splash and water jet ricocheted and simultaneously funnel all wash water to a collection barrel, possibly outfitted with a sump–pump (10 gpm) permitting the direct disposal of wash water to an oil–grease separation unit or filtration system which can be of an advantage especially in remote or sensitive areas. Kitchen oil–grease waste is not of petroleum origination therefore requires more often only the capability and consideration of customers adequate and legal waste water discharge curriculum.

The front or visible side of filter component's (Fig. 3.108) and canopy surfaces requires obvious and simple cleaning endeavors. The invisible hidden areas of a duct system which are most likely also the low air velocity areas such as those found especially behind filters, in grease filter track channels, the build up behind plenum cavities or horizontal-lateral ductwork runs, in particular on multiple floors will require a contractors full attention and capability. On multiple floors exhaust systems laterals require access panels, every 10′–15′, which can be an added business opportunity when offering the installation of NFPA approved panels. When cleaning the main hood structure a direct contact to the fire suppression system, its cables, linkages and fuses by caustic chemicals, high-pressure cold–hot water jet or nozzle-wand is uncalled-for. A contact with this sensitive equipment can possibly activate the fire suppression system. After job completion a final wipe-down and cleaning of fire suppression nozzles and fixtures, including red caps (nozzle covers) is permissible as is the reinstallation of caps by pressing them gently on to the nozzle orifice. Cleaning, vertical–horizontal ductwork (Fig. 3.109) also requires the removal of the roofs exhaust fan motor and hood structure. When lifting the fan motor off its frame a physical restriction by the electric wiring must be guarded against to avoid possible damage. Providing and installing a hinge kit for the fan assembly circumvents a risky and cumbersome removal practice. When first inspecting an exhaust fan as to its operational function and possible imbalance

GEAR - LIST AUTHORIZATION

Corrosion, fat-grease removal, chemically treating and painting (∅) of pipes, ducts and tubes

Customer & Company: Web site e-mail		Date: Address: City: State:	Job Nr: P.O. Box: Zip Code:
Purchasing: Tel: e-mail	Engineering: Tel: e-mail	Maintenance: Tel: e-mail	Safety: Tel: e-mail
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Sewers: Pipes: Air conditioning-heating system: Kitchen exhaust units: Duct work: Roof unit Evaporative cooler-cooling tower: Others:			Mud: Corrosion-rust: Mold: test: Specify: Bacteria contamination: Pests: Specify: Fats: Petroleum based: Grease: " " Oil: " " Carbon: Others:	yes	no
Pressure washer: hot-cold Hydro-blast unit: hot-cold Pipe cleaning nozzle with cable ear: Vacuum truck: Hydro-vac system: Vacu-box: Airless paint spray unit: Paint hoses: Paint nozzle centralizer: Nozzle centralizer: Cables: Other:			FDA, EPA approved chemistry: MSDS: Acid: Rust inhibitors: Caustic: Detergent: Foam nozzle: Wand extensions: 35° to 90° Cardboard wedges: Spatula: Plastic sheeting: (visqueen) Other chemicals or live micro-organisms: Rags: Other: Specify:		

Describe application and work procedure:
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.

which is in itself not necessarily a result of a grease accumulation, a contractor is best advised to inform customer of this situation, which may reveal after cleaning prior damage to the impeller fan assembly. A smooth or adverse wobbly rotation to an intact, undamaged fan can only occur if an inadequate cleaning procedure was performed leaving residual which produce imbalance to a lightweight air impeller assembly.

Roof surfaces can also be heavily saturated with fats and grease, probably a result of leakage from fan housing construction breaks or spillage by inadequate collection of grease passing through fans grease spout. Various grease collection systems are available, requiring a simple installation procedure. Cleaning roof surfaces also requires the collection of wash water and its subsequent grease content. The rain gutter can be considered a water conveyance system, but can often and only when isolated be utilized to transfer wash water to the filtration grease–oil water separation unit. The gutters are last in line to be cleaned and neutralized of any fat or grease content.

After the cleaning procedure the entire exhaust system is inspected by a properly trained and certified competent person acceptable to the authority having jurisdiction in accordance with Table 3-8.1. The job walk will quickly identify access inadequacies when determining fat–grease–oil accumulations throughout the system. Inspection access to all areas of duct vent system is of utmost importance to verify that all surfaces are cleaned to bare metal.

The entrepreneur is best advised to contact the IKEKA International Kitchen Exhaust Cleaning Association for training, licensing and possible equipment choices, http://www.ikeka.com, National Air Duct Cleaners Association, http://www.nadca.com, Indoor Air Quality Association, http://www.iaqa.org. Additional duct cleaning services can include servicing dust collection systems, stack cleaning, industrial ovens, lab hood exhaust systems, laundry exhaust systems, paint spray booth and stacks, etc.

3.9 Directional–Horizontal Underground Pipe Installations, Water Well Cleaning, Water Jet-Grouting, Pile Driving

Today, various methods are employed to install lateral horizontal-pipes or conduit below asphalted or concrete road surfaces replacing expensive trenching applications. Developed in the early 1970s, varies hydraulic pipe thrust machines incorporating a 4″ vacuum hose sleeve and a high-pressure water access fitting to the ram-block retainer situated between hydraulic cylinder and pipe assembly facilitating the removal of soil through the center of an advancing pipe assembly (pipe-jacking). This directional horizontal pipe installation technique under asphalt and concrete surfaces such as runways, highways, sidewalks etc., is supported by a sewer–pipe cleaning technique combined with a simultaneous hydro-vac procedure while removing soil and water from the advancing pipe interior. The water jet’s excavating force greatly reduces pipe-conduit installation times by reducing

friction upon pipe assembly supporting the hydraulic cylinder force through varying subsoil conditions. A protected, centered pipe cleaning nozzle affixed to the cone assembly is situated guaranteeing that water jet impact is slightly behind and within the penetrating cone edge. The pipes' lateral thrust advancing and delivering soil formation into the jetting cone, excavating soil into the vacuum supported pipe interior, reduces pipe friction and subsoil densities. The cone assembly, protecting pipe edge and nozzle may vary in size and nozzle jetting degree-angle accommodating pipe-cone assemblies interior ∅. To prevent collapse or hydraulic fracturing of subsoil areas or for that matter infrastructure is it imperative to keep the jet's final impact contained within the interior of the cone-pipe wall protecting soil, clay, silt and sand formations. The jet's velocity does only enhance the overall soil movement throughout the advancing pipe assembly. Water jetting procedures must always be simultaneously activated when an hydraulic pipe advancement is initiated. Vacuum operations, are only introduced to maintain soil flow and continuous removal to refuse collection facility. Soil conditions below parking areas, roadways, runways, etc., are generally known and do not pose an operational hazard.

Depending on the pipe diameter to-be-installed, units with the capacity of 5–35 gpm, 3,000–6,000 psi (Fig. 3.111) are applicable. This excavating method must not be confused with a core rock drilling procedure which starts at a much higher pressure and low water volumes (app. 45,000–65,000 + psi-and possibly produced by and referred to as intensifiers).

When utilizing horizontal drill equipment (Figs. 3.110, 3.111, 3.112) for small and medium underground pipe installations a pilot hole on the surface on one side of obstacle to be crossed must be established before operations can begin. The drilling follows to the designated profile below and beyond the obstacle to exit at the surface on other side. The second phase entails a correct setback and creation of a cavity sufficient to accept pipeline-conduit, utilizing hydro-vac equipment.

Pulling conduit or pipeline through the enlarged hole presents the third phase. The established key parameters ensuing from a geotechnical investigation must be followed closely which include identifying the practical pressure of drill fluid applied, pilot hole setback distances and depth of cover, which will depend on soil properties and geotechnical data gathered during preconstruction analysis. Applying adequate drill fluid pressures (Bentonite-mud) while in the directional–horizontal drilling process is a balancing act to maintain borehole stability, and sufficient pressure but avoiding the possibility or minimizing the potential to initiate excess plastic yield losing drilling mud to pilot hole or surface. These are only a few technical aspects which must be considered and can be complicated when drill speeds and drill fluid pressures are inconsistent resulting from varying soil conditions, depth and cover, utilities, various infrastructure, groundwater and space restrictions, etc.

Hydro-technologies applied to regenerate water well systems (Fig. 3.113), and perforated drainage pipes set up in gravel substrate (pack) surrounded by sand and soil designed to enhance water flow characteristics are applications made possible due to nozzle criterion similar in appearance to equipment utilized for pipe

Fig. 3.110 Horizontal drill equipment

Fig. 3.111 Pump-head (slurry)

Fig. 3.112 Drill-bit and nozzles

cleaning, hydro-vac and pile driving applications. This application differs in that a two-step cleaning process is required and begins with the verification of an adequate groundwater table involving well systems design criteria.

Necessary tool requirements will change with every man-made water well design and drainage pipe configuration, which includes altering or inconsistent soil and gravel pack conditions, well depth and well's spire drainage configuration. Sooner or later all wells will lose their water volume performance due to restrictive sedimentations such as iron oxide, magnesium, calcium and other compounds responsible for various water flow limiting crust developments which may include

adverse influences by chemical elements. Bacteria and biological effects can also be responsible for flow restrictions in perforated filter tubes. The draining area of the tubes, the water-carrying earth, gravel pack and sand (loam) will become less permeable restricting the overall water flow, including the permeability of the water-carrying substances and therefore may reduce efficiency up to 90% of the original well performance. Under most circumstances, interior drainage tubes are submerged and feature longitudinal slits or similar perforations. Steel brushes applied to clean these perforations are, at best inadequate. The sewer pipe cleaning technique is far superior due to the fact that pipe perforations are totally cleared of blockages due to the repetitive pipe jetting procedure and subsequent agitation of adjoining drainage areas, releasing sedimentation further enhancing the water flow ratio of a well. The secret reveals itself in the high-volume, low-pressure nozzle configuration; 2,000 psi, 60 gpm jet-penetrating power which will remove restrictive sustenance and agitate all exterior perforated pipe areas and adjoining well soils. This jet-penetrating performance is an industrial equipment standard and can also be produced with most of today's sewer cleaning trucks (units) ideal for this application.

Well basins are kept clear of water by operating a submersible pump powerful enough to maintain low water levels in the well casing. The well casing is serviced first utilizing the cleaning power of a 3D tank-cleaning nozzle. Most filter tubes are fitted with check valves, keeping water accumulation to a minimum.

To protect the operator during the pipe cleaning process a high-pressure hose guide assembly (Fig. 3.114) incorporating a retainer for the nozzle hose armature and a simple slight gate is affixed to the valve flange joint. Adequate cleaning of perforation is best achieved by slowly and repetitively cleaning the pipe lateral, permitting an extended but constantly slow-moving water jet dwell time. A self-propelling and centered 3D nozzle is the ideal tool for this application. Allocating an adequate cleaning time and agitation through pipe perforations of the surrounding soil-gravel pack formations guarantees in turn long-term water productivity.

All OSHA's confined space entry regulations must be introduced including fall protection, top entrance harness, plumbing take-out an lock-out procedures, and electrical lock-out, etc. (pumps etc.) Establish water-explosion proof lighting, sufficient communication between equipment operator, confined space safety man and labor force.

It is the secondary process that constitutes a complete restoration of up to near 100% well production. Lance sections of 25′ in length (schedule 100, ½″ ∅) are vertically forced into the perimeter of the well ground and sand-gravel packed perforated spear boundary. The nozzle's high velocity water (1.5 ∅ × 5 × 1.5 ∅) will clear and assist the movement downward up to 100′ with little effort.

Lance couplings are small-shouldered and can be drilled, creating two 1/64″ nozzle orifices, therefore minimizing friction in these areas. To guarantee top psi and gpm performances check the water volume capacity of available unit before drilling procedures are undertaken. When nozzle assemblies are forced within 3′ of the well depth (spear or corrugated pipe), permit an agitating 10 s dwell time to

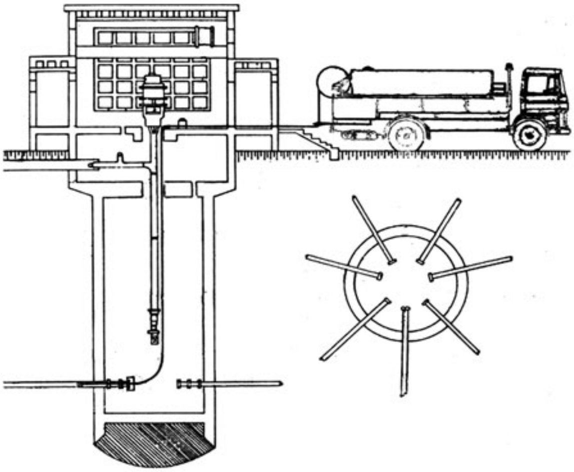


Fig. 3.113 Well casing, pipe Jeter, well spears

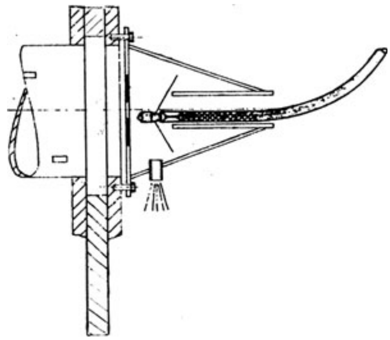


Fig. 3.114 Hp-hose guide assembly

surrounding gravel-soil filtrate before the lance pulling is initiated (section by section). A small caterpillar or front loader (Fig. 3.115a, b) can be engaged for the installation of a multiple lance fixture (3–4) as similar in its process then a soil remediation–grouting–stabilization procedure.

When utilizing a high-powered hydro-blast unit, of 150 hp plus, the operating pressure can be raised achieving nozzle recoil forces supporting the retracting of lance equipment by small and cost effective construction equipment, which must provide a 25′ lift capacity.

Working from the near center of the well, covering all essential filter spear areas, will upon completion finish the regeneration process. It is prudent to clean the inside (∅) of filter spear tubes once again applying this time a disinfectant to the water suction side of unit such as sodium-hypochlorite NaOC1 (metered). The water–chemical mix ratio is prescribed by either the chemical manufacturer or the water plant engineer. Applying both cleaning processes in a mid-size well can take up to 4 days.

Fig. 3.115 **a**, **b** Lance assembly

The high-pressure water technology has also found its way into the jetting assisted sheet pile driving method which includes river dike shoring procedures, manufacturing underwater concrete casings, bridge and subway structures, and so forth. Tens of thousands of tons of piles have been driven with the assistance of hydro-jetting technology. Hydraulic operated equipment and cranes fitted with mechanical-hydraulically energized rams sometimes incorporating vibrator-assist equipment to enhance dynamic drive are most commonly used for this procedure. Adding high-pressure water jets to the exposed sheet pile edge reduces sheets skin friction to interlocking grooves and soils with added result of substantially diminishing ground vibration velocities, important in areas where dike stability or sensitive buildings are present. High-velocity water jets will dramatically decrease the overall sheet point friction, producing in various soils a 50–70% production increase while maintaining a 35–45% material and labor saving factor. The pile sections width and soil conditions will determine the need of one, two or four symmetrically arranged small diameter hydro-lance assemblies; one or two per sheet is generally sufficient. Preventing nozzle damage, and contamination (plugging) or undue stress by soil compression and created impact-friction the jetting procedure simultaneously commences with every pile driving operation. A simple steel retaining cap providing nozzle protection is firmly welded approximately 2″ above the sheet pile edge. The ½″ schedule 80 steel lance is secured by clamping devices or a rectangular ¼″ metal strip to the sheet in approximately 6′ intervals, permitting a minimum gap of 1/8″ between the lance and the nearest point of the metal strip. When in a high pressure low water volume application (high density clay), lance deformations possibly produced in a recovery lance-pulling operation are averted. To avoid vertical slippage, a ¼″ retainer hub is welded above the high-pressure water manifold situated on the top side of the sheet pile. Prior lance assemblies retraction, this hub must be removed.

Direct weld tagging every 8′ to sheet can be employed for low-pressure high water volume applications (compact gravel-soil) where lance material recovery due to low cost of schedule 40 pipe materials justifies the loss. This also is a

GEAR - LIST AUTHORIZATION

Excavating, drilling, sheet pile driving and water well cleaning

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: State:	P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Water well: Specify: Water well systems: Perforated drainage pipes: Specify: Filter tubes: Specify: Tube drainage accessibility: Well basin ∅ and depth: Well casing walls: Specify: Filter-spear depth, length, ∅: Sheet pile: Length: Design-width: Other:		Equipment: Submersible pump: Specify gpm: Hydro-blast equipment: Hp hose guide assembly: Lance sections: Lance assembly unit: Specify amount: 3-D self-centered tank cleaning nozzle: Disinfectants: Water treatment: Pile dynamic analyzer: Pile echo tester: Caterpillar: Front loader: Specify: Other:	

Describe pile driving method and location: rail, foundation, barge or marine environments:

Describe application, tool utilization and work procedure:

Describe soil remediation and grouting procedure:

Describe geotechnical data and soil profiles: bedrock, glacial soils, marine soils, organic-inorganic soils, fill soils, etc.

Describe pile type and load classifications:

Itemize further equipment, safety gear, expendables, labor time, equipment times, etc:

criterion in specific areas where geological circumstances (sandy-mud soil, etc.) within a sheet pile driving operation call for a ground stabilization procedure. In this case utilizing lance equipment to inject cement grouts or Bentonite slurry to improve toe strengths and overall structural soil integrity and/or water tightness is the application. It must be noted that this hydro-support method has yet to confirm geological changes within high consistency soil condition as first feared by

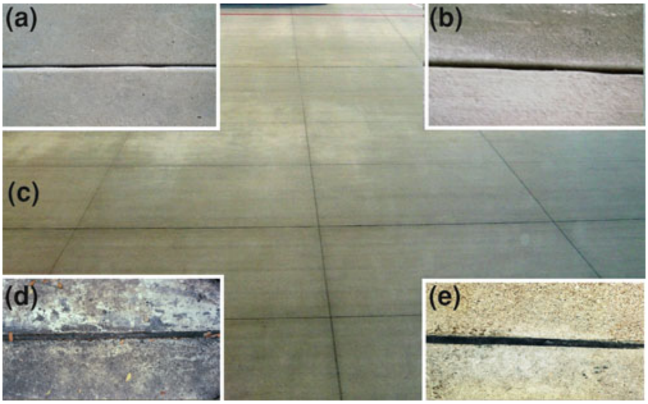


Fig. 3.116 **a**, **b**, **c**, **d**, **e** Various concrete surfaces

engineers. Water jets psi and gpm performance are adjusted to operate within the plastic yield level of various soils encountered. Compact gravel, sand and clay formations have all proven the possible reduction of rams from 3,000 to 1,300 (at equal soil conditions) to the depth of 50′ with a high-pressure water application.

3.10 Expansion-Control Joint Cleaning on Rigid Pavement, Sidewalks, Decking, Tank and Pool Construction

Expansion-control joints mainly embody the need to eliminate possible stress damage due to load, environmental and thermal influences on concrete surfaces and structures (Fig. 3.116). Stress damage is generally a result of poorly distributed or excessive loads, inadequate subsoil conditions, and water damage to soil, organic growth and excessive temperatures, such as freeze–thaw cycling. Expansion joints may also be created or added where hairline fractures are present or likely to worsen and/or when structural changes are needed. The contractor must be careful in choosing the right application criteria. Joint technology can be confusing which can include a specific joint design for a contraction, construction, expansion and isolation criteria.

The contraction joint, is a formed and/or tooled or can also be a sawed groove (Fig. 3.117) creating a weakened plane regulating the location of cracking by thermal-dimensional changes of different parts within.

An expansion joint is a separation provided between adjoining components permitting movement, where expansion is likely exceeding possible contraction of a structural component or a separation between pavement slabs filled with a compressive joint sealer and/or manufactured components sealing and providing a compressive joint placed between prefab concrete slabs.

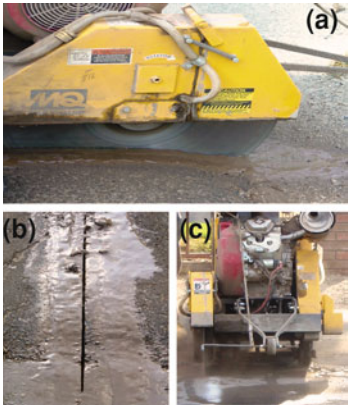


Fig. 3.117 **a**, **b**, **c** Sawed groove and its equipment

Construction joints are made in concrete before and after interruptions of concrete placement (pouring), or positioning of precast concrete units by installing strips of wood, rubber and foam, plastic or metal components.

Isolation joints are defined as a separation between adjoining components of a concrete structure generally on a vertical plane at a designated designed location to interfere least with performance of the structure, yet to tolerate relative movement in three directions avoiding formation of cracks elsewhere.

The pre-job classification should identify past project management stipulations categorizing design and type of joint, its width, depth, product, mastic-polymer, its trade name or manufacturer, design purpose and then necessary installation necessities. This greatly assists hydro-blast technicians to decide upon a correct tool selection and adjustments for the given circumstance encountered. Subject to confusion are most often contraction and construction joints. When removing product from a construction-control joint system is it important to require detailed knowledge concerning possible design variances within structural locations. Reinstallation and/or re-sealing of construction control or expansion joints require most often a dissimilar hydro-blast application criterion within a deteriorated product removal process. Application technology may also vary due to necessary installation, compression, sealing or adhesion parameters required by a specific joint product to be installed. The major application parameters are following below.

Is a contractor obligated to remove backer rod or blocking media, waterproof membrane material, and is the installation of a bond breaker or separating tape necessary or a refacing or widening of joints required? A close working relationship is essential with any contractor responsible for new installations verifying necessities of product characteristics especially when establishing backer road width in a refaced joint and its required width–depth according to proposed

Fig. 3.118 Cutting by high-pressure water

identity of the sealant-polymer material installation. Traffic and weather can play a major role within a job's progression and is critical when the cleaning and joint drying time or curing of an elastomeric is considered.

The expansion joint's width, structural integrity and desired mastic-polymer removal depth, deteriorated mastic-polymer elasticity and adhesion factors which are widely-variable parameters including the identification of its hazardous component, and disposal requirement are particulars also to be considered. Sometimes, the remaining indentation hardness of an elastomeric-polymer can be a guideline as to the removal time requirements but again can be varying due to weather cycling and products overall integrity.

3/8″ joints and greater permit the utilization of a mobile oscillating nozzle carrier adequately weighted (50%+) to overcome and control the nozzle's recoil forces, assuring the operator's safety. A plastic curtain affixed alongside the unit's exterior prevents excessive water overspray and allows a better visual control while the unit is within the advancement (Fig. 3.118).

The nozzles are adjustable and their jets are set between 1° and 5°, depending on joints cleaning width and depth. The jet's overlapping point is responsible for the cleaning depth. The nozzle angulations are set so that water jets impact is guaranteed to affect all expansion joint surfaces within a cleaning path. Nozzles located near the unit's pivot center provide the correct jet standoff distance from the joint edge and the mastic material, thus delivering the maximum water velocity to the adhesion areas. Oscillating speeds range from 60 to 360 per minute depending on the mastic's resiliency. 60′–500′ per hour are standard cleaning performances and are proven to be very successful on concrete runways, jet-bridge and aircraft parking areas, bridge decks, coal storage facilities, etc. Pressure-gpm

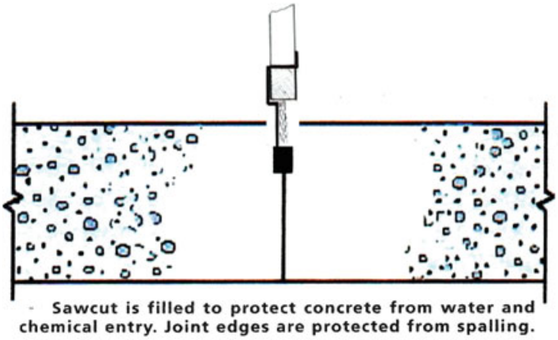


Fig. 3.119 Cutting by high-pressure water

performances of the oscillating units range from approximately 7,000–10,000 psi, 20 gpm.

Expansion joints below the width of 3/8″ create a problem due to the fact that the jet's velocity and power cannot directly or effectively attack the mastic adhesion areas, realistic jet impact angulations are therefore impossible within the straight down joint surface areas. In this case, preferably apply a high-pressure, low-volume concrete or steel cutting head in conjunction with a minimum amount of soluble abrasive medium (not exceeding 50 lbs hourly). These small joints will channel the high-velocity abrasive water mixture, removing mastics and creating an adequate porous surface. Gun barrel steel guide (Fig. 3.119) affixed to the nozzle fixture can greatly enhance jet guidance and spalling of edges. Before new mastics are installed, a thorough cleanup and drying process in the immediate joint area is essential (hydro-vac system). If required due to excessive footage, a dual or triple gun operation is advisable. Trigger-guns with water deflector shields allow a safe, more controlled work method in areas where movement is restricted enhancing the overall production rate. Approximately 5 gpm, 10,000 psi per gun is a common operating standard. The concrete–steel cutting heads are also applicable when repairing and sealing pools, fish tanks, digesters, dams, and so forth. Cracks, blisters, and fractures are exposed and then water-abrasive blasted (soluble) to gain adequate material porosity (starting with pressures at 3,000 psi and no less than 5 gpm). If abrasive materials are not desired in the vicinity a concrete scarifying unit at 12,000–22,000 psi may be the alternative or the UHP method utilizing turbo-nozzle, etc. A side note: Emerging weeds, grass, and their roots are removed in the same fashion, except a weed-killing chemical is metered to the blast water or directly applied into the joint before resealing processes are conducted. Reappearances of weed growth are highly unlikely. High-pressure water jets are extremely root-damaging and enhance the chemical action, providing a long-term weeding solution.

GEAR-LIST AUTHORIZATION

Expansion control joint cleaning, sidewalks, tank and pool construction

Customer & Company:		Date: Job. Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing Tel: e-mail:	Engineering Tel: e-mail:	Maintenance Tel: e-mail:	Safety Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

			Equipment:		
Concrete flooring:			Hydro-vac system:		
Concrete runway:			High pressure trigger gun w-deflector:		
Expansion joints:			Oscillating cleaning unit:		
Hairline fractures:			Concrete-cutting head:		
Jet bridge areas:			Chemicals (weed killer):		
Aircraft parking areas:			Chemical metering procedure:		
Aircraft hangars:			Turbo nozzle:		
Bridge structures:					
Ponds:					
Fish tanks:					
Water dams:					
Digesters:					
Cool storage facilities:					
Others:			Other:		

Describe application and work procedure:

Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:		Date: Address: City: State:		Job Nr.: P.O. Box: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:		Safety: Tel: e-mail:	
Job Description:					
Job Location:		Job Site Risk Assessment:		Specify:	©
Job Review Performed by:					
Building type:			Pressure washing - hydro-blast equipment:		
Non-expendable equipment:			Expendables:		
Product Encountered:					
Hazardous Material:	MSDS:		Specify:		
Safety procedure: Work procedure: Developed by: Authorized by:				Date: Date:	

3.11 Filters, Screens, Felts, Bag-House Units, Trays-Catalytic-Cracking, Vacuum Suction Rolls, Radiators-Fin-Fan, Air Preheater Baskets, Staggered Channel, Wire Mesh-Plate-Vane Mist Eliminators

Dismantling fouled air pre-heater baskets facilitating a cleaning procedure is a practice of the past. In fossil fueled power plants there are two cleaning alternatives available reducing the related maintenance and cleaning costs. First, the installation of a permanent and automated system, which is located on air pre-heater units' low-pressure side, can specifically reduce maintenance scheduling problems by eliminating a vessel entrance procedure. A mobile or stationary hydro-blast unit, generating a minimum of 50 gpm at 10,000 psi, will supply the hydro-power to a rotary spin-jet nozzle carrier installed to a traversing unit which moves repeatedly from the center to the outside perimeter of the basket assembly while the basket disk is in a slow rotation. The jets will penetrate upward through hardened and crusted materials throughout a 12-ft basket structure. Early tool designs successfully applied nozzle carriers utilizing three jets incorporated to the traversing unit. Operating at approximately 60–80 gpm at 10,000 psi a lesser vulnerability as to failure was the major advantage especially when applied to the vacuum side of a basket structure. In any event, the nozzle design and standoff distance will be selected in accordance with various basket depths and fouling characteristics. The physical design of a standard jetting nozzle does not permit a tight jet configuration throughout excessive and obstructed blast distances especially when utilized by a spin-jet. To compensate for inadequate nozzle design criteria the experienced technician will make up for resulting energy loss by enlarging nozzle orifices ∅, accommodating water mass (volume) to the necessary psi performance, which is a prerequisite and only possible when adding the horsepower requirement. A tight water jet configuration resulting from an advanced design criteria will deliver far superior jet standoff distances dramatically reducing horsepower necessities. Cleaning baskets from top side of a rotary assembly utilizing the same stationary or mobile traversing technology highly automates this otherwise rigorous manual procedure.

The second option requires the manual operation of hydro-blast trigger-guns requiring confined space entry procedures. Operators experienced with these units will not be able to outperform a mechanical system. However, where material deposits and density drastically varies, the manual and systematic basket area-to-area performance criterion is more effective, avoiding the repetitive and time-consuming mechanical method when isolating and cleaning the problem areas. Extensively-soiled units throw loosened products above the basket surface while in the cleaning process. To allow oversized materials to pass through the basket grid, either the manual shredding (hydro-trigger gun) or the simultaneous use of the hydro-vac unit is suggested, avoiding the shredding procedure. Sufficient lighting,

Fig. 3.120 Air preheater basket

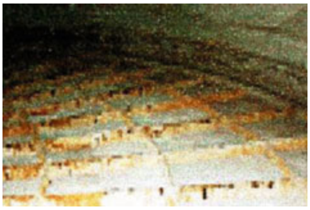


Fig. 3.121 Fouled basket

in area being cleaned is of utmost importance; verify lockout–takeout procedures on vessels plumbing and electrical circuits.

Scrubbers and mist eliminators (Fig. 3.120), distillation columns and acid mist scrubbers applied in reclamation processes may also remove mist droplets of sulfuric and phosphoric acids from stack gases, such as those found in chemical processing systems. These systems incorporate a wire mesh, zigzag or wing-baffled structure in wood, metallic, plastic or fibrous design to separate mist droplets of 35 μm plus from massive air flows, also common in vent stack mist eliminators, which are found in paper-pulp mills. They are applied especially when product carryovers are constant or a given possibility (Fig. 3.121).

Fiber bed mist eliminators in cylindrical or panel construction are installed to prevent a visible stack plume. Special attention is required when choosing a specific tool selection and subsequent psi and gpm configuration. A cleaning process must prevent damage to the fiber-plastic materials, possible when gpm performances and nozzle stand-off distances are incorrect. Misuse of turbo nozzles can create substantial damage to a fiber-plastic structure. The highest-quality fan nozzles (15° to 20°) will prove effective at 5,000–10,000 psi. Nozzle orifice ∅ (gpm) is selected by recognizing penetration requirements concerning the mist eliminator's structure and product accumulation, density-tensile strength.

One must be careful to protect fiber-plastic materials which are sensitive to direct jet impact and more so to high water volume velocities possibly required when removing stubborn crusted materials.

Sufficient lighting in units confined space, adequate and safe footing protecting the fiber-plastic bed structure and understanding the unit's design criteria is of utmost importance to correctly identify fall protection.

In most industrial plant situations fin-fan air cooled or heat exchanger cleaning is nowadays semi or automatically performed. For emergency repair situations a manual cleaning application or the utilization of a portable service unit is practical. The manual exterior cleaning of fin fan structures must be undertaken with care.

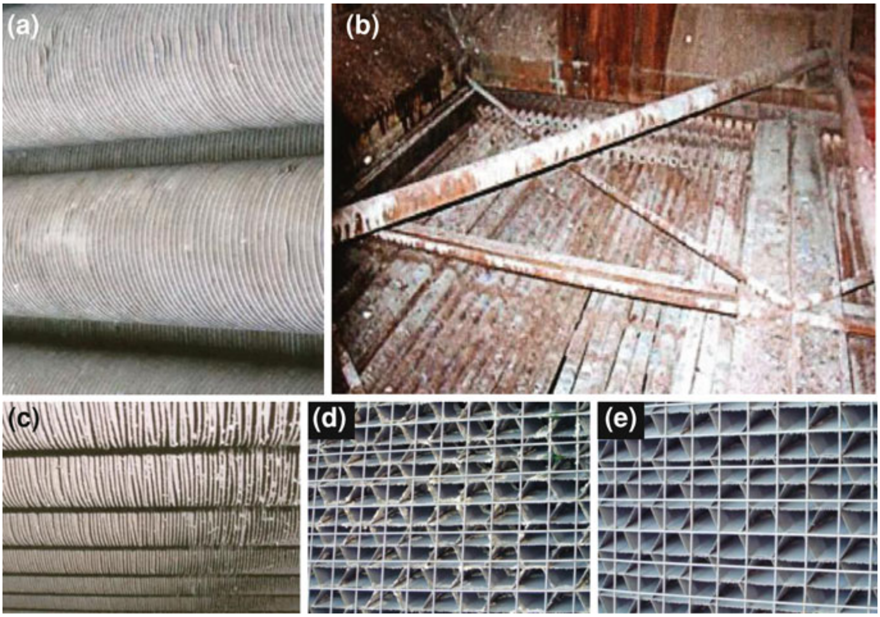


Fig. 3.122 Fin-fan exchanger (**a**, **b**, **c**, **d**, **e**)

Obviously sensitive metal-aluminum fins (Fig. 3.122) cannot be introduced to physical contact by a trigger-gun barrel's nozzle assembly, nor can pressure or water volume configurations exceed fin strength, resulting in deformation. The criterion is only the depth of fin fan tube structure reaching all surfaces by manipulating the gpm–psi configuration (Fig. 3.123).

Single, dual or triple round jet nozzle assemblies are most effective and deep penetrating with least of lateral force development to fin-fan structure, especially on horizontal units. Most damage to fin structure occurs through operator slippage-contact. Space restrictions are often encountered when servicing commercial units on roofs or in confined equipment space which requires flexibility in tool design and their application.

At some stage during a plant service cycle the necessity to overhaul a self-cleaning baghouse unit (Fig. 3.124) is sometimes complicated considering the existing combustible explosion threat (dust). Adding to the fire triangle of oxygen, heat and fuel, the deflagration of dust particles in sufficient quantity and concentration can cause a rapid combustion especially in a confined space or enclosure such as buildings, vessel or equipment.

The utilization of industrial vacuum trucks can be relatively risky due to development of static electricity, and heat generated by necessary tight gear-blower tolerances (mashing) and the high temperature transference to the muffler assembly possibly causing equipment fires and/or explosion when a filtration breakdown, overload scenario or grounding interruption occurs (debris-box).

JP SERVICES

INDUSTRIAL
CLEANING
SPECIALISTS

April 8, 1987

Mr. Kelly Fitzpatrick
Powerine Oil Company
12354 Lakeland Rd.
Santa Fe Springs, CA. 90670-9861

Proposal No. 147

Dear Mr. Fitzpatrick:

Pursuant to our meeting on Tuesday, April 7 at Powerine Oil Company, your request for the cost of cleaning seven (7) banks of Fin Fan tubes, I submit the following:

JP will pressure wash outside diameter of your seven (7) banks at the cost of $602.00.

<u>CONTINGENCIES</u>

1. Payment terms are to be net fifteen (15) days.

2. Any delay to contractor will be charged at time and material rates.

<u>POWERINE OIL COMPANY WILL SUPPLY</u>

1. Water at 70 P.S.I./50 G.P.M.

2. Permits

3. Contact man

I believe JP Services, Inc., can offer you safe and economical methods of Industrial cleaning, transportation and environmental services. We insure our compliance with all federal, state, and local regulations.

Fig. 3.123 Powerine proposal

The removal of accumulated dust and bag house fines in volatile agricultural, wood, chemical, metals, plastic and carbonic dust environments can safely be performed utilizing various hydro-vac methods. A possible electric static charge created through friction within a vacuum hose assembly does not occur due to the constant equipment grounding-conductivity by water jet transference. The vacu-jet pump does not retain mechanical parts to develop heat or any other ignition source.

Practical application variations are categorized into three methods; either directly pulling dust accumulations and debris through a vacuum injector assembly, utilizing 4″–6″∅ vacuum hose runs, avoiding all contact or filtration problems by liquefying bulk dust to be deposited in tanker–trucks, evaporation, settling

Fig. 3.124 Baghouse unit

ponds, or landfill. This situation also permits the placement of power-pack, pump stations and vacuum injector off-site when services are performed in or near volatile vessels, equipment and areas. The second alternative permits conveying product over excessive elevations and distances by establishing an off-site pump station continuously loading and pumping by incorporating sludge-mud transfer equipment. The third possibility and often applied is the dry product removal method utilizing mobile vacuum containers (roll-off box) energized by high-powered hydro-vac pump equipment to permit the possible product return to process or dry storage requirements.

When cleaning interior surfaces of centrifugal separators, rotary sieves, drum or disk filters, one will find a similar tool selection when powdered or dust accumulations must be removed. The application and safety variances lie within the industrial environment encountered and their products manufactured. The air pollution control systems filter bags (fabric) draped over cages are most often cleaned off-site. Pulled over a cage the interior surfaces are cleaned by a centered dual 45° fan jet T-assembly at 200–800 psi.

Necessary cleaning pressures do vary according to fiber type of bags encountered. Processes, pending their structure can be of cotton, nylon, glass, polyester, etc. Interior shell surfaces are subjected to a 3D tank-cleaning nozzle for the wash-down application. Interior cleaning applications range widely from 1,000 to 8,000 psi, 2.5–22 gpm; utilizing trigger-gun with affixed turbo nozzles, fan jets from 15° to 45°, depending on encountered substrate and material or the adhesion of sedimentation. Once again, the final tool selection is chosen when understanding the manufacturing process, type of sedimentation or calcification involved and the overall design integrity of a unit specified. This includes being aware of varying safety equipment and its application.

So-called suction rolls in paper mills (Fig. 3.125), belong to the filter element cleaning category. In operation, or on arranged maintenance intervals, process operators either utilize a trigger-gun fitted with a 20° fan nozzle (no more than 6,000 psi) or a timing device activating a repetitious cleaning system incorporated

Fig. 3.125 Suction role

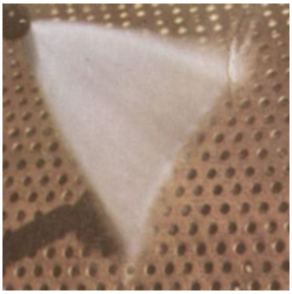
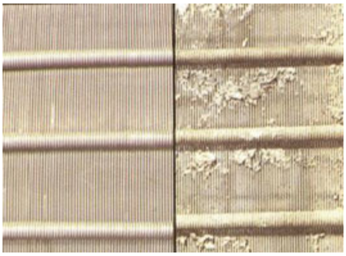


Fig. 3.126 Filter plates



to the felt roll-off point, enhancing the paper product's quality and felt production lifespan. The interior diameter (∅) of a dismantled suction roll is cleaned at approximately 6,000–8,000 psi, bringing a T-lance fitted with two 20° fan jet nozzles to action or utilizing a centered 2D nozzle carrier. Frequently, their cone-shaped orifices best release adhered scale accumulations when the nozzle velocity is first applied onto the narrow side of the cone. Cleaning the outer perimeter of the suction roll is therefore of an advantage. Important: Be aware of the direction of production process-flow throughout a suction roll and all other air or fluid filtration systems. Material adhesion is best broken down by applying the jet's velocity against the units production flow, characteristically providing a better or rougher surface structure, permitting a greater jet-penetration factor, therefore, when technically possible, cleaning procedures must start at the gravity vacuum or discharge side of any given unit. When repetitious work becomes necessary, stubborn, adhered products have most likely been neglected in previous cleaning procedures and may escalate the prior estimated cleaning time. Above all, it is important to clean all areas in depth. This drive for excellence is also important when cleaning filter press systems hydrating industrial sludge. Their filter plates retain fine, horizontal or vertical channels (Fig. 3.126). The filtrate emerging from the filter cloth is drained throughout these cavities. Developing crust and obstructions result in production time losses. Deposits are removed by mechanically-driven fine-toothed steel brush possibly adding a surface profile. Medium pressures of 3,000–6,000 psi, at 4–9 gpm and trigger gun-operated 15° to 20° fan nozzle will solve this application much quicker and without the possible damaging effect of harshly-employed steel brush applications. For standards related to fire and dust explosions, http://www.nfpa.org, NFPA, 654, 61, 484, 664, 655, and for

combustible dust national emphasis program, safety and health information bulletin (SHIB) (07-31-2005), combustible dust in industry, http://www.osha.gov.

GEAR-LIST AUTHORIZATION

Filters, screens, felts, bag-house units, trays for catalytic-cracking, air-preheater baskets, etc.

Customer & Company:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: © Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	
Job Review Performed by:			

Fin fan air-cooled or condenser: Air pre-heater baskets: Scrubber, mist eliminator: Distillation columns: Acid mist scrubbers: Wire mesh (zigzag): Wing structure (wood, metal, plastic): Vent stack mist eliminators: Fiber bed mist eliminators: (cylindrical, panel, specify Ø):			Centrifugal separators: Specify: height, , access: Rotary sieves: Drum filters: Disk filters: Suction rolls: Filter presses: Other:		
Equipment: Hydro-blast unit: Round jet (hard-hitter): psi: gpm: High pressure trigger-gun: Lance extensions-T-lance: Flex lances: Fan jet : 15°, 20°, 45° psi: gpm:			3 D nozzle: Specify: psi: gpm: 2 D nozzle: Specify: psi: gpm: Nozzle centralizer: Specify: Vacuum hose :∅ Vacuum-hose: length Hydro-vac equipment: Specify: tooling Vacuum roll-of box: Other:		
Product Encountered:					
Chemical: hazard: describe:	Yes	No	Specify:		
Describe application and work procedure: Mud pumps: Pump station: based on-site, of-site: Specify:					
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.					

3.12 Cleaning of Gas Stations, Bank and Restaurant Drive-Thru's, Machine Shops, Warehousing and Parking Garage Areas, Airport Runways, Jet-Bridge and Hangar Facilities, Vehicular-Pedestrian Tunnel Surfaces

Surface cleaning or so-called flat work, is best divided into three basic application identities;

1. High-pressure water washing or cleaning of residential and commercial properties, creating in its function no ground water contamination nor utilizing the storm water conveyance system. This is a prerequisite which mandates that no surface water is discharged to storm sewers, but also includes doing away with a non-hazardous wastewater discharge from house washing operations, resulting in carrying sediment and turbid water on to sidewalks, road surfaces, street gutters or any other conveyance method (ditch) with direct access to aquifers, rivers, lakes and/or sea.
2. High-pressure water washing or cleaning of residential and commercial impermeable surfaces, protecting at all times the storm water conveyance system while creating a non-hazardous effluent resulting from hot high-pressure water cleaning techniques, supported by a range of soaps or mild chemicals. The removal of oil, grease, fats, wax and sediment residual results in an admixed wastewater stream identified and recovered for reduction and pertaining to the governing sanitary sewer district regulation (POTW) disposed of as wash water pH neutral.
3. High-pressure water washing or cleaning of residential, commercial and industrial properties where typically a waste stream is created when utilizing hot or cold high-pressure water to remove coatings, various types of industrial waste products, coverings and corrosion often supported by solvents, abrasives and/or chemical surface preservation products. Removed solid waste must be identified and recovered, blast water recycled and filtered, solvents recycled or reduced for correct disposal and/or incinerated.

Hospital main and emergency entrances, supermarket loading-receiving docks and customer entrances, hotel arrival portals, atrium display and entertainment areas, pedestrian sidewalks, city park grills, benches and tables, open-air park structures and tourist facilities, city center expositions, fountains and culinary exhibition areas, subway entrances and exit surfaces, pedestrian areas in botanical gardens and zoos, stadiums and their customer and sport facilities. In short, all surfaces where one must not worry about the water runoff created when applying hydro tools utilizing cold water between 3,000 and 6,000 psi at 4–10 gpm. These applications most often belong to the number one category of wastewater management, and most often require water recovery (Fig. 3.127) and vacuum tooling avoiding overspray or possible misting events (Figs. 3.128, 3.129). Surface areas require barricading procedures displaying warning cones, safety tapes, signage and

Fig. 3.127 Water bladder berm

Fig. 3.128 Vacuum generator

Fig. 3.129 Vacuum berm

Fig. 3.130 Drain cover, water bladder

primary–secondary (Fig. 3.130) protection for accidental wash water release to the storm sewer system (Figs. 3.131, 3.132).

Secondary protection requires water barriers and covers for various street gutter designs and the subsequent storm drain access, preferably incorporating at the

Fig. 3.131 **a**, **b** Hotel arrival portal

Fig. 3.132 Oil–grease residual, before–after

lowest area a backup vacuum-shoe which is independently activated in the event of primary wastewater control failure.

The simple closed-loop oil/water separation and wastewater neutralization technique should be modified when utilizing hot water 200°F, between 2,500 and 6,000 psi emulsifying heavy oil and grease accumulations especially in hot weather. Today available mobile equipment varies dramatically in operational gpm performance to separate emulsified oil/grease from a wastewater stream (2.5–15 gpm) setting in motion the number two wastewater treatment requirement.

Gas stations (Fig. 3.133), toll-booth, bank and restaurants drive-thru, in short, all areas accumulating oils, grease and food remnants on stop and go concrete and/or asphalt surfaces are routinely serviced. Cleaning intervals depend on traffic volume, access possibility and climate (temperature).

The application criterion for gas stations and restaurants drive thru may differ slightly in support of durability and aesthetic maintenance efforts. Today's polymer modified concrete surfaces feature a reduced permeability (oil-stain), a improved abrasion and freeze–thaw propensity at tensile strength of 4,800–6,000 psi supporting a cleaning solution by high-pressure water incorporating only a mild detergent if so desired (Fig. 3.134a) Nevertheless, gas stations and their fuel companies are considered generators of accumulating petroleum waste products. Therefore, all waste streams removed from their facilities must be handled within the hazardous waste removal criteria (cradle-to-grave). The modern gas station-convenience store may also operate a carwash facility, sometimes contractually utilized to receive their acidic-alkaline wastewater which is neutralized on site to

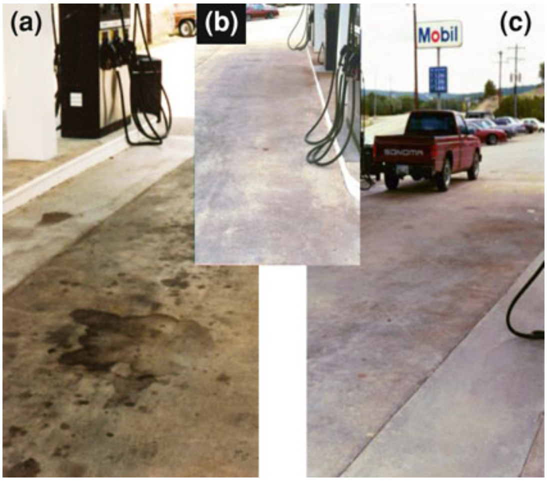


Fig. 3.133 **a**, **b**, **c** Gas station oil–grease residual before–after

pH 6.5–7 and disposed of. Job setup procedures must be thought-out regarding populated, traffic oriented and possibly volatile-gaseous environment. Gasoline and diesel fuel powered pressure washing equipment cannot be situated within the vicinity of any fuel system. This is seldom a problem; the area to be cleaned must be free of equipment, tooling and vehicles (Fig. 3.134b). Contractors equipment will feature a spark arrest grounding wire attached to the equipment while in operation maintaining ground to the designated system which is likely to be found within the underground fuel tank area. Eliminating possible sparks by covering battery terminals with semi liquid silicone is also a good idea.

Sanitary sewer district regulation and EPA pending, detergents can by admix to the jetting water or applied directly to a soiled area to by toiled in by broom (pump-up sprayer) which is followed by a vacuum retrieval (Fig. 3.134c) application into a designated container.

Professionals fine-tuning their cleaning capacity for large surface areas above 10,000 ft^2 hourly, are most often also under time constraints. Utilizing a trigger gun mounted injector (abrasive) permits a quick and precise foaming detergent application over extended distances (40′–60′ standoff distance). Foaming and dwell-time characteristics are generally far superior to available foam nozzle equipment developed for fleet or house washing operations. Water–chemical ratio is determined by pumps-gpm performance and chemical flow controlled by needle valve adjustment to injectors vacuum hose. The abrasive hose and hose barbs are exchanged for a ¼″ chemical hose. Ratio tests and verification are best performed when timing the fluid draw (water). Water drenched surfaces may not reveal the development of ghosting while in a jetting procedure (fan-jet). Rotary surface cleaners and spin jets are in their application most effective to curtail ghosting scenarios often encountered with novice operators. Cleaning capacity (carts) should guarantee at all times a minimum effectiveness of 8,000 ft^2 regardless of the distinctive surface soiling found on the above mentioned areas. Correctly

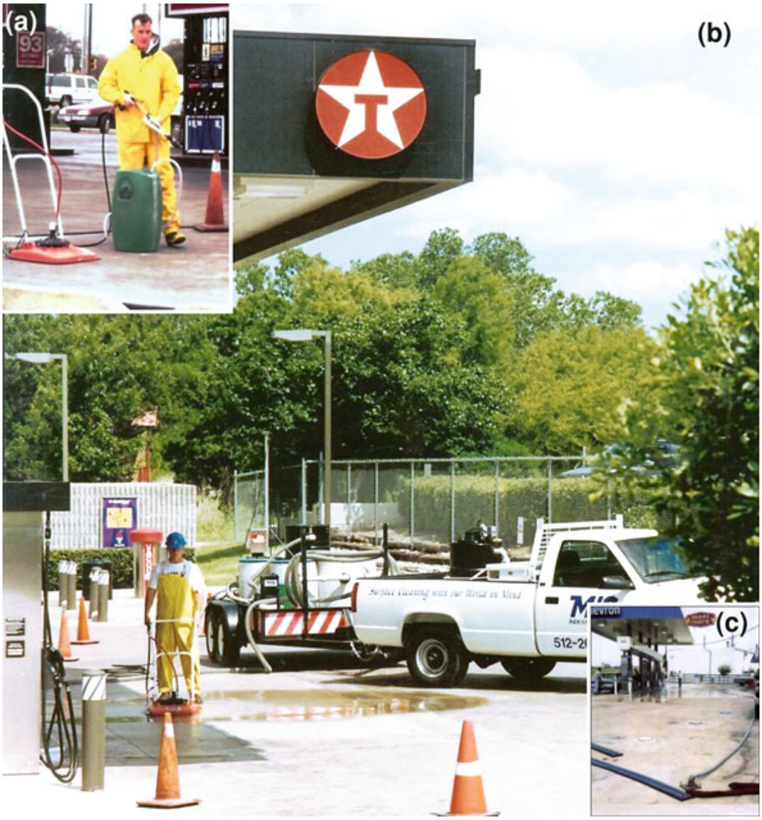


Fig. 3.134 **a**, **b**, **c** Equipment set-up

set-up rotary equipment will ideally produce approximately 9,000–11,000 ft^2 at 3,000–6,000 psi, and if necessary operating at 200°F plus, at approximately 5.5 plus gpm. Forward cleaning performance is subject to available psi–gpm, nozzle set up and rotor rpm, nozzle standoff distances and adequate unobstructed hp-hose feed. Circular ghosting is a result of excessive forward thrust (Fig. 3.135) or reduction of rpm due to water pressure loss and/or rotary swivel failure. When purchasing rotary equipment to utilize hot or cold water at 4–10 gpm, let supplier assure hp-swivels' effective stand times. High-pressure swivels drastically vary in their performance criteria which facilitate the nozzle arm rotation (nozzle body). Excessive leakage within a rotating seal is immediately recognizable and visually noticeable by systems pressure gauge indicating a pressure drop. This is only factual when nozzles, pump packing, valves and pressure regulators are in full operating condition and systems pressure side is free of internal–external water leaks. Compensating for a lost gpm output by raising engine rpm is not a solution especially when operating with extensive high-pressure hose assemblies.

Fig. 3.135 Spin-jet ghosting

Fig. 3.136 Fan-jet ghosting

Due to traffic loads, toll booth, bank and fast-food drive-through surfaces are usually serviced at night. Almost always these areas are designed with a natural runoff capability providing the self-explanatory placement and position of water barriers and vacuum shoe.

Contaminated with bubble gum, foodstuffs and grime, sidewalk cleaning for restaurants and shopping areas can be considered a fundamental job classification. Problems arise when time estimates are required for various spot removal procedures on a variety of substrates. Asphalt, concrete, brick pavers, granite, lime and sandstone substrates require specific attention. Their individual surface uniqueness, especially in hot environments sometimes also contaminated with asphalt and/or bituminous products besides bubble gum can be frustrating. Pressure and temperature requirements on various substrates are adjusted to prevent ghosting (Fig. 3.136) and/or damage, especially when pavers are encountered which are installed to a sand filled-base. Adjusting nozzle impact degree on a rotary surface cleaning unit can be required. The utilization of hot water best above 200°F plus at 3,500 psi is ideal for most surfaces. Especially for bubble gum residual, temperatures above 200°F are necessary. The higher the temperature the easier gum will melt away. Pressures must be reduced for lime and sandstone

Fig. 3.137 Parking facilities

pavers. Correctly estimating cleaning times on porous and or frail substrate (sand-lime stone) is largely based on experience supported by timing the cleaning of 1 yd.^{2} within the severest and the least contaminated area (demonstration) and comparing the remaining surface appearance to a visual reference identifying the percentage of the overall spot contamination. This visual reference is also applicable for all other surfaces (The Book of Spots by Lydia M. Ph.D. and Charles A Frenzel). Water barriers and covers are arranged avoiding accidental discharge to the storm sewer conveyance system. Barricading and signage for work area is mandatory and includes the area of equipment and hose runs. Daytime work is most often complicated by pedestrian and vehicular traffic. A contractor should not underestimate the problematic of applying chemicals in busy areas, especially on windy days.

Besides the human factor, misting adversely affecting vegetation, awnings, windows and possibly parked vehicles can quickly become a gigantic headache, even though the chemical and visual effects are deemed minimal.

Floor and surface cleaning applications such as those found in underground or elevated parking facilities (Fig. 3.137), differ substantially to the bank, restaurant and gas station drive-thru criteria. Contracting bidders submitting offers for services to city-owned structures and nowadays most private garage businesses require a DUNS number (Data Universal Numbering System), obtainable by contacting Dun & Bradstreet, http://www.dnb.com/us/and the central contractor registration, CCR at, http://www.ccr.gov. Deteriorating and outdated concrete classification, years of penetrating oil and grease, various repeated cleaning endeavors and accumulations of remaining trace elements, deteriorating coatings, concrete abrasions and environmental damage etc. are typical to most aged garage structures. Older units may also exhibit advanced concrete carbonation and carbon dust contamination, wind swept debris, bird-pigeon droppings and a variety of traffic problems. Most often these typical conditions determine a quarterly or biannual weekend schedule providing necessary cleaning services at night. Before a jetting procedure is implemented, the structure must be studied to identify possible damaged expansion joint systems, concrete micro fractures, or any other possible circumstance permitting water to seep out or through to ceilings and walls of the next level below. Identifying this leakage possibility is best done at the time of a preliminary job walk. When studying prior staining events on ceilings, especially around recessed light fixtures and electric open wiring, light switch

Fig. 3.138 Parking garage

Fig. 3.139 Grease oil deposit, before

Fig. 3.140 Grease oil deposit, after

fixtures etc. is it important to notify property management of such an alarming circumstance. Garage structures (Fig. 3.138) may also be part of an emergency exit-access by pedestrian and emergency vehicles alike and must be considered when designing the job procedure and equipment distribution throughout the cleaning process (Figs. 3.139, 3.140).

The closed loop removal and filtration-recycling of the created waste stream can be controlled when cleaning top down by utilizing the existing drainage system. Most often this requires a prior pipe-cleaning application of the system. Generally, garage structures primary, and secondary drainage lack the necessary water velocity to self-clean.

Over time, where extended intervals of sweeping are utilized expect a heavy debris burden within pipe and, if present, clarifier. Once cleaned the waste-water flow can be isolated by various methods. The pipe-systems cleanout flanges are utilized for the installation of pipe and sewer plugs (Fig. 3.143) isolating the down

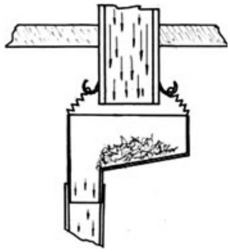


Fig. 3.141 Catch basin

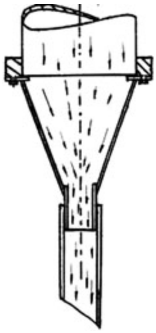


Fig. 3.142 Funnel receiver

stream pipe and sewer access from the developed waste-water stream. The plugs are pressurized-operated by either air or water which can be manually performed. A vacuum hose fixture (Fig. 3.142) or collection trough (Fig. 3.141) is installed befitting a range of pipe or cleanout ports within their physical locations (one). Incorporating the bottom vacuum flange connector for remote operation of the water filtration–reclamation and hydro or pressure washing pump closes the wastewater cleaning cycle. Due to time and area constraints, the physical movement of equipment and trailer is quite impractical. Garage design pending high-pressure hose runs are guided up through the center of a unit with quick coupler access for each floor, or in approximately 25′–50′ increments. Cleaning performance should always be above 10,000 ft^2 per hour per 20 hp drive input.

The clean-ability of any coating system refers to the removal of dirt, grime and other contaminants resulting from environmental, storage and manufacturing procedures. Various coatings are designed to withstand the rigors of sanitary and decontamination procedures on coated surfaces such as in food, medical, nuclear and military application environments. Contractors often confuse clean-ability to abrasion and erosion resistance. The clean-ability and scrub resistance is mainly a function performed on the topcoat of any coating system, which may include a verifiable resistance to detergents, solvents, fuels and chemicals.

Also a high-pressure water cleaning processes for coating systems intended to be maintained one or more times during the coatings lifecycle may only appear as a cleaning function. In reality the job description called for the removal of oxidization of topcoats surface structure facilitating a reinstallation of the same.

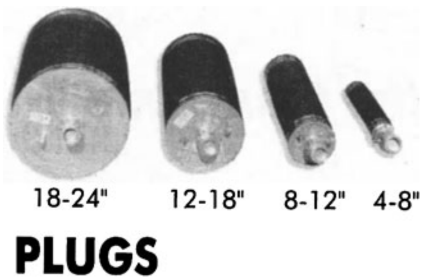


Fig. 3.143 Sewer–pipe plugs

Under these circumstances the necessary water pressures will range from 6 to 12,000 psi depending on the equipment utilized.

Nonskid coating surfaces installed to resist harsh chemicals and heavy steel or rubber-wheeled loads are found in chemical processing and storage areas, educational and health care facilities, food processing or meat cutting areas, automotive manufacturers and dealers, aircraft hangar and or general warehousing complexes etc. Typically, these advanced floor systems are comprised of 2–4 layers, starting with an optional elastomeric membrane, followed by an epoxy prime coat. The third layer is a matrix of coarse, at times colored, abrasive (quartz) and 100% solid epoxy to provide the necessary strength and chemical resistance. The final coat, also an option, consists of a clear epoxy finish which adds extra protection and an attractive gloss. When cleaning such coating surfaces with high-pressure water the following parameters must be established: Identify the make of the sub-floor (brick pavers, butt metal, quarry tile, concrete, or wood), and its condition for satisfactory coating adhesion. Often industrial coatings can hide damaged, badly eroded, spalling-blistered or irregular pitched floors. Under these circumstances varying coating thickness, strength and subsequent vulnerability throughout can be expected. Manufacturers' physical property sheet, specifying hardness (shore), generally 70–85, compressive strength generally between 17,000 and 19,000 psi and tensile strength ranking upward from 12,000 to 13,000 psi cannot be trusted when identifying the necessary pressure range for cleaning operations. The cured film thickness, described in mil may vary in reality due to sub-floor's structure. The bond strength to concrete is specified in psi (300–600 lbs) or as "concrete fails before loss of bond". The experienced contractor will use this information to avoid guesswork in the set up of his tooling. When the sub-flooring consists of steel and concrete spin-jets for corner work and rotary surface cleaners are the ideal tool combinations. Exerting pressures between 3,000 and 6,000 psi utilizing dual 15° or 25° fan nozzles will remove all surface debris and expose a constant color tone. Precise jetting parameters are achieved by the manipulation of jet-carts forward speed, rpm and psi–gpm configuration combined with the available nozzle variety and adjustable nozzle stand off distance to the coating surface. Black cover (rubber) high-pressure hoses tend to leave streak and pulsation marks when situated or pulled over hard porous surfaces. To prevent this, hose slack is maintained on surfaces to be cleaned. Effective and precise high-pressure hose placement, manipulation and its unobstructed feed by a

Fig. 3.144 Dual spin-jet operation

secondary operator to the rotary jet-carts is of utmost importance when cleaning large hangars or warehousing complexes. The water runoff control by water barrier, squeegees, natural flow and strategically placed vacuum shoes recovering the waste stream can be mandatory especially when buildings are not connected to a private water treatment facility. Square footage performance (Fig. 3.144) utilizing two times, 20 hp = 40 hp drive capacity will clean a minimum of 20,000 ft^2 per hour.

A coating installation to a tile and or brick floor-substrate tolerates a similar cleaning practice. Tile-brick grouts are generally super hard and do not require further attention. In these areas the water runoff capability is part of the structures design, featuring a floor drain system. The floor drains are generally installed at the lowest surface pitch or ground level and will guide accumulated water to the water barrier and vacuum shoe area (by drain opening). These applications are typically found below product assembly lines, meat processing areas, commercial kitchens, produce production facilities (canneries), stadium seats and walkways, etc.

Electrical outlets are generally open drip-proof (exterior design) and situated so as to accommodate the structures industrial purpose. Regardless of the outlets design, apply plastic sheeting in combination with caulking (silicone) to seal them. Do not point a jet or a reflecting water jet in the direction of the electrical outlet. If circumstances permit, disengage and lock-out the circuit breaker, isolating these receptacles. Reengage circuit breaker only after the job is completed and all materials are removed from the receptacles.

When rotary jet carts are too bulky and unpractical due to obstructions (concrete or mechanical fixtures), apply a spin jet affixed to a trigger-gun barrel at 2,000–3,000 psi and no more than 5.5 gpm. Fan jets at 25° or 15° are also suitable. Often surface cleaning applications are not pursued primarily due to the notion that reflecting water jets and their subsequent water velocities are not controllable. Guiding the water ricochet-misting and flow in critical areas, a contractor will require tooling specifically designed to the encountered application. Such tooling is inexpensive and can consist of ¾″ ∅ to 1½″ ∅ sand filled, soft light weight flexible hose (both ends capped) or various water bladders and plastic coverings. Weighted hose retains and guides cascading waters to the drainage area. Various water barriers of static (bladders) or vacuum design, incorporating a suction shoe is placed on the lowest point (pooling area). When cleaning massive spread-out

areas can it possibly be necessary to incorporate a secondary vacuum shoe which is alternatively moved to water pooling situations. Powered by hydro-vac and/or water recovery, filtration and recycling equipment, most available gear is capable of removing 10–20 gpm plus.

Pedestrian concrete bridge decks and walkways are most often susceptible to ghosting events therefore also best cleaned with a rotary surface cleaner (jet-cart) performing at 8,000 ft^2 per hour plus. Depending on bridge size, a tank truck with power washer unit in tandem is of an advantage. Equipment mobility is essential. Safety procedures are subject to pedestrian and vehicle traffic. Wastewater runoff must always be controlled and reclaimed. Necessary pressures range from 3,000 to 6,000 psi at gpm equipment pending.

Runway cleaning, or better the removal of residual rubber created by aircraft tire friction has been offered to airport maintenance departments since the mid 1960s with the availability of compact equipment and in doing so applying up to 600 hp. Today, truck mounted and vacuum supported rotary surface cleaners, retrieve created waste stream simultaneously, separating rubber residual while in a continuous cleaning process. This also permits shorten maintenance emergency procedures between runway takeoff and landing frequencies.

The actual psi–gpm requirement is quite often overemphasized when equipment necessities are introduced, especially where gpm–psi performance must be kept within the concretes limitation to adsorb the high-pressure water velocity within the concrete–rubber interface. The following application practice is in some locations or jurisdictions outdated but must be understood to correctly identify similar application criterion.

Airport maintenance and managers expect a certain performance capability from competing contractors. Technical provisions are provided to the interested parties prior to the bidding procedure and read as follows; The certification of a contractor must include that the contractor's equipment has been demonstrated or used in the performance of a contract which has taken place at a US air force base or civil airport and this certification must be signed by the base civil engineer or airport manager. Further, this certification must contain statements that the contractor and his equipment have the capability to remove a minimum rate of 10,000 ft^2/h, and if necessary 85% removal rate of loose paint on runway markings. Liability insurance of 4–6 million dollar is considered a standard for most commercial airports and can present a problem for smaller contractors. Reliable radio communication equipment is a must and is required when accessing a runway. No personnel or equipment shall be allowed on the runway prior to radio contact (tower) with airport operations obtaining verbal permission. Emergency landings and takeoffs always take precedence over all contractors operations. In the event that the lead man or safety man is notified that an emergency landing or takeoff is imminent, the contractor must stop all operations immediately regardless of the sequence of events in progress and at once evacuate all personnel from the runway. To do so, military-N.A.T.O. airports provide a 2-min time frame and commercial airports up to 4 min. In this time frame it is imperative to double-check the runway surface for any forgotten tools, which should not be there in the

first place. A runway clearance is considered complete when the linear distance of personnel and equipment is moved a minimum distance of 200′ away from the nearest edge of the runway.

At the end of a working shift, all equipment must be brought to a location, designated by maintenance or contract officers, that is not less than linear 750′ ft away from the nearest edge of the runway.

For payment of rubber and paint removal, the unit of measurement should be the actual number of square feet accepted by the maintenance or contract officer. Payment for downtimes inflicted by airport operational circumstances will be rounded off to the nearest hour (this is of importance to the contractor). It can be expected that a change in air current or unscheduled traffic loads, emergencies, etc., delay cleaning procedures frequently.

The contractor will supply all mobilization, labor and equipment when performing the necessary operations to remove rubber deposits and loose paint from the areas designated by a drawing submitted by maintenance. The removal of rubber and paint from asphalt–concrete or concrete runways shall be accomplished exclusively with high-pressure water. The use of chemicals or abrasive materials will not be permitted. The water which is used for any high-pressure water equipment will be available from the sources shown on supplied drawing at no cost to the contractor. The contractor shall furnish all equipment, water trucks and labor to provide the delivery of the water from the water hydrant or dispenser to the job site. The contractor likewise shall furnish all necessary labor, hoses, wrenches and all other tools and equipment for filling tank trucks. Permanent-type installations of overhead piping to fill water tanks, which may preclude the use of the fire hydrant by the fire department in case of emergency, will not be permitted. Equipment, tools and machinery used in the performance of rubber and paint removal shall be at all times safe and in satisfactory working condition. If the high-pressure water is delivered from a spray bar, the nozzle's jets shall be so configured as to provide total coverage of the area being treated. The contractor shall remove 85% of all visible rubber and restore the asphalt–concrete pavement to a natural surface. 80% of loose, flaking paint, as designated, shall be removed. Hard, firm paint with removed chalk may remain. A medium water pressure of 6,000–8,000 psi shall be used (today, UHP criteria is of advantage).

The treatment of the rubber and paint surfaces should not be injurious to the asphalt–concrete surface, expansion joint sealant or runway lights. If it is deemed by the engineering department that damage to the existing pavement was caused by an operational error, such as permitting high-pressure water application to dwell in one location for any extensive period of time, the contractor shall repair the damage without compensation. A runway sweeper and driver will be furnished and operated by the contractor for the cleaning off of paint and rubber debris from the runway when requested to do so by the engineers. This information is standard in the industry and will vary only slightly due to equipment and runway specifications.

The major rubber accumulations are found within the first 3,000′ on both sides of the runway heads (Fig. 3.145). The four large paint stripes are generally 150′

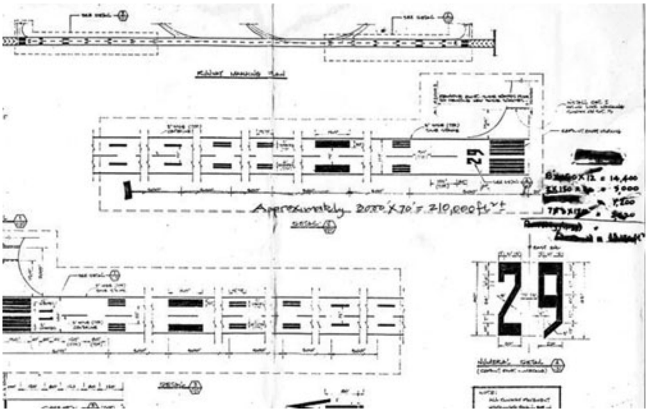


Fig. 3.145 Runway specifications

long and individually 15′–30′ wide and the 52 smaller stripes are 150′ × 6′. Runway border marks are continuous and measure 3, in width. Numbers are 60′ long and vary in overall width between 5 and 20′. A standard runways length measures approximately 9,000′–15,000′.

Early surface cleaning units specifically designed and assembled to accommodate this application featured large water supply tanks with two to four hydro-units individually rated at approximately 150 hp, releasing their hydro-energy upon the runway in utilizing an oscillating or stationary spray bar assembly containing fan nozzles. The metered hydraulic drive capacity moves the vehicle down the runway at required speeds. Certain manufacturers did try to introduce abrasive cleaning methods by exerting their energy via a spray bar assembly and releasing oval abrasive jet patterns upon the runway, failing to convince customers of potential advantage. The newly-developed, rotary surface cleaning units, either self-propelled or energized through hydraulic motors are far superior in their cleaning performance and produce a more favorable horsepower–psi–gpm ratio, cleaning precision, surface cleanliness, application variety, and last but not least, a lesser cost factor in maintenance and purchase price.

Asphalt runways resist high-pressure water jets up to approximately 6,500 psi; however, this does not mean that asphalt will withstand a constant jet impact at these pressures. The precise operating pressure is determined on the job site. Due to climatic conditions and general asphalt structure, the actual rubber adhesion variables with regard to the runway surface permit, at times, operational pressures of up to 7,000–7,800 psi and then again lowered to 5,500–6,000 psi. (The UHP criterion differs dramatically in psi–gpm configuration.)

The rotating arms including nozzles are adjusted to clear all obstacles, such as runway lighting bulbs and center dividers. Manually operating a surface cleaning unit in a single or dual rotor construction with a cleaning width of approximately 3′ × 3′ × 6′ may be the solution to permit a contractor not yet established in this business (application) an opportunity to compete in upcoming bid offers.

A hydro-blast unit coupled in tandem with a tanker truck establishes the power-pack assembly, maintaining in this form the necessary mobility. When operating, a 20′–30′ high-pressure hose with quick couplers permit the prompt water refill mobility and emergency evacuation of the runway and presenting the flexible lifeline to the rotor cleaning unit. Once adequate nozzle-psi configurations are established, operators are able to work quickly, accumulating approximately 3 miles per hour. Jetting operations may be interrupted due to water refilling procedures and the truck's directional changes. Preferably start jetting operations at the outer perimeter (truck turning radius permitting), then move to the center line of the runway. Ice shaving units perform in this manner (skating stadiums); this permits the best possible turning radius for the truck and the hydro-unit and therefore enables the most uninterrupted jetting procedure. The existing slack of high-pressure hose provides ample lateral movement for the operator, creating a visual seamless surface appearance and minimizing drag forces and possible rubber markings. Whatever operations one performs it must be certain that personnel and equipment can exit the runway within 2 min, leaving no physical trace. A three-man crew is adequate. One will operate the surface cleaning unit. The second, a lead man is responsible to keep in touch with flight operations (tower) and is at all times in communication with them regarding the runways operational status. He also shares the obligation to maintain all prior safety and tailgate meeting criteria. In case of an emergency evacuation the lead men will follow behind the withdrawing equipment to check for forgotten tools and debris and observe all required distances between runway and operators-equipment. And only then, when all safety precautions are met, will he inform the tower-flight control of runway status. The third man is responsible for operating the truck and trailer. A second truck is located in safe, but close proximity to the runway which in an emergency is mobilized to pull stalled vehicles from an imperiled location. Always keep in mind that maintenance chores are never performed within runways vicinity. Airport's base civil engineer will purposely specify the roads to the water source it is therefore understood that an alternative route is never used without explicit approval. Filling the water truck is done best by utilizing the fire department's overhead tanks. Because hydrants are comparatively slow in their filling procedure, valuable time can be saved in this manner (designed to fill fire truck tank within 2–3 min).

Rubber is generally deposited on approximately 450,000–500,000 ft^2 and is removed in two 8-h shifts demanding a minimum cleaning rate 30,000 ft^2/h. This is comfortably achieved by operating a dual rotor surface cleaning unit. Some equipment design engineers claim that a surface polishing effect is more likely by applying high-pressure water only. This however is incorrect and most likely thought of to convince customers to use a water abrasive blast method. In actuality the opposite may occur because a highly-angled abrasive jet stream may hone a surface. Concrete runways of a B-400 plus substrate are less sensitive to climatic circumstances therefore simply dealt with by raising operating pressures to overcome the interface adhesion factors of the encountered rubber build-up. Intact concrete may destruct between 11,500 and 13,500 psi. While in the jetting

Fig. 3.146 Expansion joint

procedure avoiding expansion joints (Fig. 3.146) completely is best or a pressure adjustment is necessary to avoid damage to joint's structure and bituminous product. Again, it must be emphasized that this application description is geared to industrial contractors utilizing high-pressure water equipment which can be successfully converted to perform this application avoiding purchase of specialized runway cleaning equipment.

Flight deck substrate on aircraft carriers is manufactured of steel therefore it will constitute no pressure limitations for the contractor other than the job specification. These specifications are identified as: total base removal, base spot removal practices and rubber or paint stripe removal. Tooling consists of a skid or dual axle-mounted 150 hp hydro-blast unit incorporating the vacuum supported multi-head rotary cleaning or product removal equipment. The water source is either located on the plane elevator nearest to the work site or in bay area of the flight deck. High and low pressure-hose runs can be excessive. The actual operating pressure is similar to the rubber paint removal application on concrete runways (Fig. 3.147b, c); however, since most vessels are serviced dockside they do not maintain an operational flight deck therefore safety procedures are less stringent. Pressures range between 8,000 and 36,000 psi, gpm according to equipments cleaning width, and available horsepower input. At times it is necessary to install a secondary filter cartridge to avoid contaminating water from pier or vessels potable water source. All safety procedures are specified by the naval shipyard or its contractor.

Remember. High-pressure hose runs can be extensive and sometimes require, on the farthest end, a pulsation dampener which will harness the pressure peak developed by the moving water mass throughout the hose line when water flow is shut off.

Plane taxi, parking and jet bridge areas (Fig. 3.147b) are outlined with paint stripes and are in need of periodic cleaning when oils, rubber and food residues enhance possible tire slippage, when they appear visually faded, or when removed to suit constructional changes, etc. Applying the dry sandblast method, a common practice with paint contractors, is utterly outdated. Self-propelled or manually operated rotary surface cleaners are most suited for this application. Manually operated trigger-gun mounted spin-jets (Fig. 12.22) are ideal for working in obstructed jet bridge areas around the outlined machinery complexes. Jet-carts

Fig. 3.147 **a**, **b**, **c**, Rubber removal on runway (far-right)

ordinarily designed to remove highway road markings feature two nozzles within the width of standard road striping. The versatility of this unit is ideal. Contractors can apply them to spot clean surfaces or to remove rubber paint and 3 M foils. When spot resurfacing practices are performed utilizing higher pressures they can also be applied to scarify concrete or asphalt surfaces. Operating pressures range from 5,000 to 14,500 psi and produce up to 18 gpm.

A single or multi-gun operation is possible (fan nozzle or spin-jet fitted) and is sometimes necessary within this surface cleaning application. Under these circumstances safety procedures are somewhat more elaborate. Place traffic cones, and affix barricade tape and warning signs restricting access to trigger-gun operation and general designated work area. Equipment and accessories are located so as not to interfere with the movement of planes, jet bridge tires and structure, fueling, baggage and maintenance vehicles. The operating pressures range between 3,000 and 11,000 psi, 5–22 gpm equipment pending.

At this point, let us refer to the water abrasive blast method. Recently, a major hydro-manufacturer successfully developed water soluble abrasive material (patented). By impact dissolving and traceless, environmentally sound resulting in a new application variety which can be explored. A multitude of grains are available to polish, etch, hone and remove materials.

Vehicular–pedestrian tunnel surfaces are, due to disproportionate air movement introduced to surface contaminants, susceptible to water jet ghosting events. The application of chemistry is most always of advantage especially when applied with

GEAR - LIST AUTHORIZATION

Cleaning of gas stations, restaurant drive-thru, machine shops and warehousing

Customer & Company: Web site: e-mail:	 Fig. 3.148 manually operated rotary surface cleaners		Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:		Explain surface condition:	
Bank drive-thru: Restaurant drive-thru: Gas station drive-thru: Parking garage Parking lots: Bridge decks: Sidewalks: Other:		Concrete substrate: Asphalt substrate: Cured epoxy: Contamination: Oil: Grease: Bubble gum: Other:	
Overall cleaning width and length: Star time: Finish time:		Overall square footage to be serviced: Other:	
Existing surface damages: (explain)		Safety procedures: (explain)	
Blast water available: Blast water dischargeable:		Acid treatment: Acid neutralization: Detergent: Surface pH: Rust converter:	MSDS:
	psi gpm		
Pressure washing equipment Hydro-blast equipment: Rotary surface cleaner: Abrasive injector-chemical injector: Trigger-gun-fan nozzle: 15 25 45 Trigger-gun-spin-jet: Jet cart: Vacuum-recovery:		Water recovery, filtration and recycling : Vacuum truck: (CFM? Mercury?) Vacuum shoe: Vacuum house: Feet: Water barriers: Barricades: Protective skirting: Other:	
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.:			
Environment	Industrial	Commercial	Residential

a converted abrasive injector. Utilizing rotary surface cleaners of any type and trigger-gun mounted spin-jets is an essential prerequisite. Waste stream recovery is almost always necessary. Tunnels often feature glazed tiled surfaces requiring the utilization of an excellent wastewater recovery, filtration and reclamation capability to avoid a visible residual film buildup.

3.13 Hazardous Industrial Waste Recovery and Soil Treatment, Asbestos, Radioactive Trace Element Remediation, Vehicular Accidents, Cleanup of Crime Scenes, Demilitarizing Warheads-Bombs

Available pressure washing, hydro-blasting and UHP tool accessories offer applicable solutions distinctively suitable for hazardous industrial waste recovery. Organic–inorganic, non- and volatile products can safely be manipulated, dry recovered or pumped, handled by various techniques and packaged for transport or storage. At the same time, hydro-vacuum applications are exceptionally matched for recovery of accidental dry or wet release or spill of chemicals in open or confined space, and/or in volatile explosive, flammable or gaseous environments. Hydro-vac technologies are utilized for three hazardous material cleanup requirements to remove man-made chemical hazards from water, soil and impermeable, confined or open surfaces.

The remediation of contaminated soil can be effectively performed by removing and/or reducing contaminants to meet environmental threshold limits (Fig. 3.149).

Directly incorporating the hydro-vac application criteria, utilizing cold or hot water for the passing of contaminated soil through the water-jet configuration greatly supports the physical agitation and release of oil, fuel, phenols, pesticides, heavy metals, etc. This dramatically enhances buoyancy when soil saturated water settles. The designated process equipment facilitates the rise of effluent concentrations to the surface for further treatment by filter, centrifugal separation, flocculation and evaporation processes, etc.

Organic–inorganic filtration techniques, hydro-centrifugal separation, flocculation or chemical dosing units, stripping towers, aeration or biological soil treatment and/or confined stationary–mobile biological treatment equipment can be employed on or off site. These soil remediation techniques are vital where solutions from “cradle to grave” must facilitate regulatory approval. Contaminated through commercial and industrial activities where chemical-oil spill threatens a water course, or human habitat often found in the vicinity of commercial–industrial accidents, gas stations fuel storage facilities, asphalt and bituminous product manufacturing or in fuel and petrochemical production environments and associated tank farms are all areas of immediate interest for employment of this technology (Fig. 3.150).

Applying high pressure water within the asbestos abatement and removal application is sometimes viewed as controversial. Contractors involved in manual asbestos abatement removing ACM products (scrapers) will argue that the use of high pressure water will add to the disposal costs, and create a messy work area, promoting packaging difficulties or can be costly in case of water damage to substrate. In short, not practical. Their opinion is understandable as it would dramatically alter their work practice; downsizing work force, reduce chargeable hours, accelerating containment and material packaging procedures (ACM) and the reduction in chargeable equipment costs. To protect their markets, equipment

Fig. 3.149 Soil washing plant

Fig. 3.150 Soil condition after cleaning-remediation process

manufacturers and their engineers will further argue that high velocity water adds to the possible airborne activity; they justify this with the explanation that asbestos materials impacted by a water-jet are not controllable in their removal process. When the hydro-blast or pressure washing industry is confronted with these types of opinions they will simply quote their customers involved in the daily asbestos abatement process, which does little to explain why, how and what type of specialized hydro equipment is available or necessary. Regulatory agencies such as OSHA, EPA, city and state regulating bodies and their inspectors are therefore, at best, confused because they witness both success and failure when jetting techniques are a part of the ACM's removal process.

All of the prior mentioned opinions are inaccurate especially when one considers that high pressure water jets are successfully applied in nuclear power plants for decontamination practices where airborne particle activity must be held to an absolute minimum and the adding of excessive water, then contaminated, is impractical and not acceptable.

Asbestos containing materials and products manufactured before 1981 are still present throughout private, commercial and industrial environments. There are basically three varieties of asbestos; chrysotile, amosite and crocidolite. Some ACM products can be brick, pipe or sewer pipes, textured paints and coatings, spray insulation, filter products, vinyl floor tile and adhesives, HVAC duct insulation, ceiling tiles, roofing felt and shingles, etc. One will find the products in boiler rooms or heat producing areas (pipes), on ceilings incorporated to a multitude of structural designs in commercial, industrial and public buildings, on steel

Fig. 3.151 Components and tooling splash diffuser

Fig. 3.152 Assembled splash-mist guard unit

beam construction, or throughout merchant and naval vessels utilized as a heat-fire retardant, and so on. Asbestos containing materials (ACM) are installed by various methods; they may be fused to products such as in floor tiles, sprayed on, painted or in sheet form, pre-molded or molded on a job site and covered with a retaining fabric material which sometimes is also painted.

The physical circumstances encountered within an asbestos abatement procedure can result in a variety of application utilizations requiring a technically versed knowledgeable crew. As job necessities change within various structures and areas a flexible hydro tool variety is important to offset fore mentioned negative opinions. Permissible exposure limits (PELS) to an airborne concentration of fibers, greater than 0.2 μm of air during an 8 h time waited average or a concentration of asbestos in excess of 1.0 μm per cubic centimeter over a sampling period of 30 min fiber per cubic centimeter cannot be permitted.

Continuous personal air sampling (Fig. 3.151), most often a requirement while in the asbestos abatement procedure can be achieved, by simply assembling a plastic water bottle with three scouring pads preferably of plastic nature avoiding the wetting of air stream and therefore filter medium by ricochet water spray. The filter assembly is located in the top section of bottle for easy access filter change (Fig. 3.152). This air sampling unit is affixed to operators shoulder pad near full mask or cartridge filtration equipment. OSHA regulations regarding the

monitoring of asbestos exposure, use of protective gear, including respirators, establishing a negative work environment by enclosure, ventilation system and filters, resulting in the reduction of exposure to permissible airborne activity are rigorously imposed. OSHA provides regulations on set up of job enclosures including HEPA filtration, and the establishing of negative environments. Similar to lead abatement procedures a clean room for workers must be established (street clothing), a shower room must be provided and a change area for asbestos contaminated clothing separately incorporated. Asbestos workers must undergo a medical examination and are periodically monitored. Work sites are clearly marked and access limited to authorized personnel only. These are only a few regulations in a substantial and forever changing job requirement.

All tool varieties are chosen with one theme in mind which is, regardless of tools functionality that they may not contribute to airborne activity. The hydro-vac wet mode systems are therefore ideal; not only do they provide packaging, wetting and removal advantages but in their working mode support the immediate product removal in its air negative state superbly controlling airborne activity. Within the continuous cleanup course the contaminated water is recycled for wetting, vacuum creation, negative airflow and jetting procedures. Obviously, the contaminated water volume, especially on larger jobs is therefore held to a minimum.

Any utilized hydro-vacuum exhaust box system must feature a high efficiency particulate air filter (HEPA) capable of trapping and retaining 99.97% of mono disbursed airborne particles 0.3 μm or larger in diameter.

The regulatory agencies expect contractors to perform a wetting process to bind all particles that are likely to become airborne when the actual product removal process begins.

So, one must ask, what does a proper wetting process constitute? ACM products come in a wide variety, they may be brittle, hard and spongy or a friable material, meaning that these friable materials can be crumbled, pulverized or reduced to a powder by hand pressure. Further, they are thick or thin layered, sprayed on or preformed (encapsulated) to fit pipe radiuses or machinery parts, etc.

Water absorption factors vary widely with ACMs. Area temperatures, product dismantling time, product location, accessibility, product thickness and permeability are some factors considered. A wetting agent admixed to the spray water mist may enhance the longevity of the moisture content within the product. Pressure washers' or hydro-blast units' gpm performances are generally too high, therefore not permitting a metered fluid mist application.

Preferably a secondary unit operating at 1 hp delivering 1.5 gpm (adjustable) with an optional fog and fan nozzle is of an advantage. Wetting always precedes the jetting and removal application. To avoid incomplete saturation due to water runoff and evaporation, the wetting procedure is undertaken within 5 min before an actual ACM removal application commences. An EPA recommended wetting surfactant added to jetting water, consists of 50% polyoxyethylene ester and 50% polyoxyethylene ether can be effective on various asbestos containing substrates. Nevertheless soaking or penetration of ACMs does depend on the composition of

encountered product. Working in tandem with the jetting, dismantling crew (teamwork) is most effective.

Adjustable nozzles are mostly ineffective due to their internal surface configuration. They do not permit best possible fogging, chisel, or pin point configurations, subsequently disturbing the all important nozzle stand-off distance and water jet impact capability. This is especially noticeable when operating such nozzles with pressure washers at 3,000 psi.

A rule of thumb. When product wetting times cannot be established, operators must physically check the product for sufficient moisture content (necessary water saturation). On the other hand, when a high product volume and the associating square footage requirement constitutes wetting by pressure washer or hydro-blast unit in combination with a fog nozzle, the fog nozzles must accommodate equipment's gpm–psi performance for maximum effectiveness. Nozzle gpm–psi performances are established by encountered application variety within numerous low-pressure-gpm ranges.

Also understanding the risk factor between friable and non friable asbestos products is of utmost importance. A friable asbestos containing material is one that in a dry state can be crumbled by hand pressure. A friable example of an asbestos containing material is the spray-on fluffy fire proofing material. The non-friable asbestos containing materials do not crumble with hand pressure. For instance vinyl floor tiles may contain asbestos fibers, which under normal conditions will not release fibers. The condition of asbestos containing materials is probably the most important factor. Damage to surfaces can dramatically alter and accelerate the release of dangerous fibers otherwise contained within their structure.

Under these circumstances utilizing a fog nozzle is recommended and/or imperative. A fan jet for a wetting procedure is insufficient due to waters high velocity-turbulence creating wind swept and water-product ricochet adding unnecessary contaminated water and airborne activity.

According to their installation, ACM removal techniques will vary widely. Roof structures can be joist and beam or waffle slab, and/or steel beam construction which will prove difficult for adequate access and requires a flexible tool selection. A tool specifically designed to remove sprayed on products on steel deck, concrete slabs, etc. consists of a vacuum hose connected to a vacuum shoe which is directly affixed to a high-pressure gun barrel to permit the product removal and collection in one procedure. The high velocity air moving the product also decreases airborne activity within the workplace vicinity. When applying the hydro-vac wet mode system three operational steps are performed in one (Fig. 3.153).

The vacuum hose is applied to remove detached ACMs to the packaging drum. The drum head will separate the excess water from the material, and then the ACMs are released to the drum floor. The blast water is returned into hydro-pump's isolated water supply tank for recycling procedures. The water supply tank must feature a HEPA filter unit accommodating the vacuum jet's airflow, volume and velocity. Water can be adequately cleaned with charcoal filters, however all collected asbestos waste must be tested and correctly packaged before a release and transportation to an authorized toxic waste site can be performed.

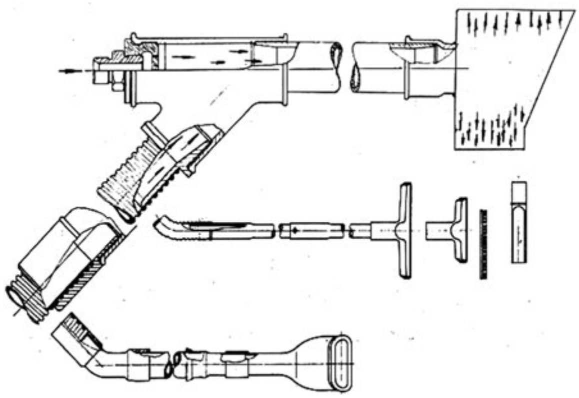


Fig. 3.153 Hydro-vac wet mode system

With the wide variety of applications available, further explanation as to ACM removal practices with high-pressure water is secondary because anyone involved must first understand the guidelines and licensing procedures established by OSHA, EPA, city and state regulatory agencies. Great application variances exist between friable vs. non-friable asbestos structures or sources. Tooling and cleaning techniques are absolutely subject to these guidelines.

Never consider an asbestos product removal practice or method, including job bidding procedures, before a thorough and licensed educational program has been completed by all persons involved. Once training and all licenses are obtained, a contractor with an understanding of all physical and legal limitations will narrow the tool variety down to the most practical combination. These days licensing procedures will involve literally anyone touching this application. Licensed individuals include: asbestos abatement contractors and their personnel involved with project managers, supervisors, individual consultants and agencies, inspectors and asbestos management planners, air monitoring technicians, training providers, transport and storage facilities management and laboratories. There are registration application forms for workers, physician's statement and notification forms. Environmental Protection Agency, National Emission Standards for Hazardous Air Pollutants 40 CFR, section 61.141, subpart M (1984), Asbestos containing materials guidance, http://www.epa.gov/asbestos.jsp.

A contractor should acquire asbestos health protection rules and the asbestos licensing section provided by the Department of Health. Further, OSHA Department of Labor #29 CFR part 1926.1101 is useful literature necessary to understand the complexity of this application, http://www.osha.gov. All states provide a list of asbestos training providers with conditional approval to train in their respective states. Laws vary in governmental, military, corporate, public and private environments.

In the nuclear material-handling industry, such as nuclear power plants, both hazardous and non-hazardous areas are vital and lucrative for industrial service providers. The plant's safety procedures are tightly controlled constantly monitored and must be studied in depth by all service and hydro-personnel. Applying

high-pressure water as a tool in nuclear power plants or facilities for decontamination, decommissioning, or plant dismantling practice does not destruct the radioactive material; rather, it is a process of relocating the materials to the smallest available space to allow their regrouping (ALARA). Radiation is released from plutonium and uranium 238. The radiation emission values depend on the size and mass of the particles found. More mass equals more radiation. Radiations of β- and γ-rays are biologically highly destructive and α-rays are comparatively safe. These rays are found on production tools, treatment basins, transportation vessels, storage tanks, tubes, drains and walls. A highly-radioactive coarse contamination (mass) presents no problems within a cleaning process. Removing fine contamination, however, represents a more complex situation and is monitored and secured by battery-operated sensors during the work process. Caustic soda, Phosphatized degreasers or biodegradable detergents are added to the demineralized or salt removed jetting water. The concentrations are standardized, generally ranging from 4 to 10% (diluted), and most often provided by plant maintenance department. Chemicals are metered to the suction tank of a pressure-washer or hydro-blast unit via injector or independent metering device. Depending on the applications, pressures may range from 3,000 to 10.000 psi, 5–19 gpm. Atmospheric contamination by vapor release is minimized when applying low-volume, high-pressure water. Steam-cleaners (hot pressure washers) are by nature not suitable. Fire hose applications add too much water volume to the contaminated product and further lack effective velocity. The hydro- and UHP method reduces the contamination significantly below the operational radiation standard (ALARA). When removing graphite deposits in uranium bars, generally located on the interior ∅ of the bar assembly it is important to recognize the fact that uranium bars are situated 9′–10′ below the water line in immersing basins. When cleaning is required the bars are affixed to a vice-like fixture.

The internal cleaning procedure is achieved by operating a remote-controlled pneumatic–hydraulic unit. A rigid lance featuring fan nozzles or rotary whirl-jet is moved in and out of the uranium bar while the bar is rotated by pneumatic–hydraulic drive covering all necessary internal surfaces. The results are unmatched by any other cleaning method. The pressure requirements are 8,500 psi at 19 gpm. The rigid lance is 6′ in length and has a ¼″ ∅. The lance guiding system is developed with the consideration of plant maintenance departments' specs. Qualified contractors will decontaminate the Rx cavity to 70% from unit's operating deck. The actual decontamination to ALARA standards, meaning "as low as reasonably achievable", is performed by three operators and a cleaning crew of two.

The first operator controls the decontamination unit (recoilless spray assembly), the second controls the overhead service crane, and the third is responsible for controlling the hydro-blast unit. All three operators communicate with each other as well as with the plants safety engineer via a headphone communication set. Upon draining the Rx cavity the Rx head assembly is set to its location and totally protected with a yellow flame-resistant polyolefin shroud which is lowered over the Rx head by the crane in such a fashion as to provide a water mist tight seal. The shrouds design and fastening/sealing components are manufactured in

conjunction with the plant maintenance department. Shrouds installation is completed within 3 h.

The decontamination fixture is lowered into the cavity by the overhead crane and is situated below the overflow trough. Before the high-velocity jetting water can be applied a repeated low-pressure wash-down at 200 psi (fog nozzle) is necessary to subdue the otherwise airborne activity. This is done section by section to avoid any possible surface drying before the high-pressure water jetting phase can be completed. After sectional surface wetting, the hydro-blast unit is adjusted to 6,000 psi.

The pump's gpm performance is determined by the nozzles spray bar design and will vary with the manufacturer. At any rate, applied water volume-to-surface blast must by effective within the maximum required operational performance. The crane operator is responsible for moving the recoilless unit in a repetitive section-to-section procedure toward the bottom of the cavity. Furthermore, to secure an even wash-down pattern he should always overlap his previous spray pattern. Operations are discontinued when wash-down procedures have reached within 2″ of the cavity floor.

Smear surveys are conducted throughout the washed area to ALARA standards. Once decontamination standards are met (approximately 15 K ppm) the two-man crew will descend to the upper Rx cavity floor.

The crews tooling consists of a hydro-blast gun with a dual fan-jet assembly, scrubbing pads (scotch-bright), a squeegee, and a sufficient supply of biodegradable detergent and towels provided by the plant's maintenance department. Again, the crew commences with a wet-down phase (at 200 psi), starting 6′ up the cavity wall (around the Rx head) downwards into the total floor area before the manual cleaning procedure, at 6,000 psi, is performed. Excess water will at all times be moved with a squeegee to the lower cavity. Once the total area has been subjected to the high-pressure water the biodegradable detergent is applied and vigorously scrubbed into all surfaces (starting 6′ up cavity wall) and floor space with the scotch-bright pads. The blasting, wipe down, and scrubbing procedure is performed approx. four times. Nevertheless, after the second procedure the cleaned area is wiped semi-dry to conduct a smear test to gain understanding of the decontamination levels (by ALARA standards). After the third procedure, plant maintenance will conduct smear tests to identify hot spots and will at this point decide if a further total wash-down is necessary or if the isolated areas are to be scrubbed by hand. A step-in-out area is created to the lower cavity once ALARA standards are met and the cleaned area can be entered without respiratory gear. General access (without respiratory gear) to the lower cavity is most likely not required; however if it is desired, the cleaning procedures are equal to the cleaning method employed on the upper level.

When the Rx cavity refueling practice commences the Rx head stud-ring (Fig. 3.154) is cleaned by scrubbing and wiping or by utilization of the hydro-vac brush system.

The studs are decontaminated by plant maintenance in a Freon HNS-200C tool cleaning system. Prior decontamination-cleaning of studs and stud-ring also

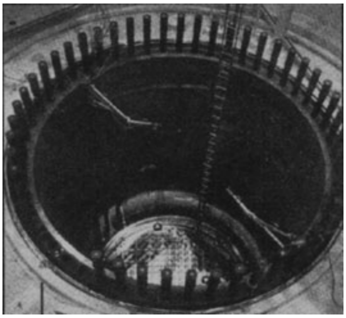


Fig. 3.154 Rx head studs

permits maintenance crews Rx head reassembly avoiding the wearing of bothersome PPG and respiratory gear. Again, it is imperative to keep airborne activity to a minimum. One should only utilize highest quality industrial fan nozzles which are designed to perform near mist-less at 6,000–10,000 psi and UHP equipment utilizing turbo or rotary nozzles, if possible, utilizing hydro-vac equipment. The standard estimated time to complete a unit of this type is approximately 68 h. Further decontamination procedures can involve the operational deck, machine shops, holding tanks, piping internals and floor drains-sumps. Heat-exchanger, condenser, feed water heater services (Fig. 3.155) utilizing flex lance equipment, removing calcium carbonate from ash water lines, cleaning cooling towers, and dredging water reservoirs are applications also periodically performed.

Macabre, but real is the cleanup and decontamination of crime scene, tragedy and trauma resulting from accident, homicide and self-inflicted death. Compliance with OSHA-DOT-EPA and HAZMAT regulation is crucial. The work environment can be industrial, commercial, residential and of agricultural nature and nowadays involves clandestine drug lab decontamination and cleanup (meth-lab), mold remediation and environmental disaster cleanup.

The availability of certified crime scene clean-up technicians who are specialized in biological recovery procedures are of importance. Service provider must establish a written blood borne pathogen exposure control plan concerning decontamination–remediation of biological origination (blood, bodily fluids-fragments) or other potentially infectious waste, and/or materials, providing a written respiratory and personal protective equipment program (PPE), and establishing a technical procedure for a hazardous communication system and vaccination program for their technician-labor force.

These are only a few standards expected to be maintained by a serious service provider. Pressure washing and/or hydro-blast equipment paired with tooling selected to provide application variety which includes a hydro-vac system, 25–45 hp, vacuum drum, packaging and effluent separation, HEPA filtration, chemical metering device, etc. are basic tool additions complementing this sometimes overlooked profession.

A cradle-to-grave hydro-blast application to demilitarize bombs by removing explosive materials from shells interior is nowadays an automated hydro-blast

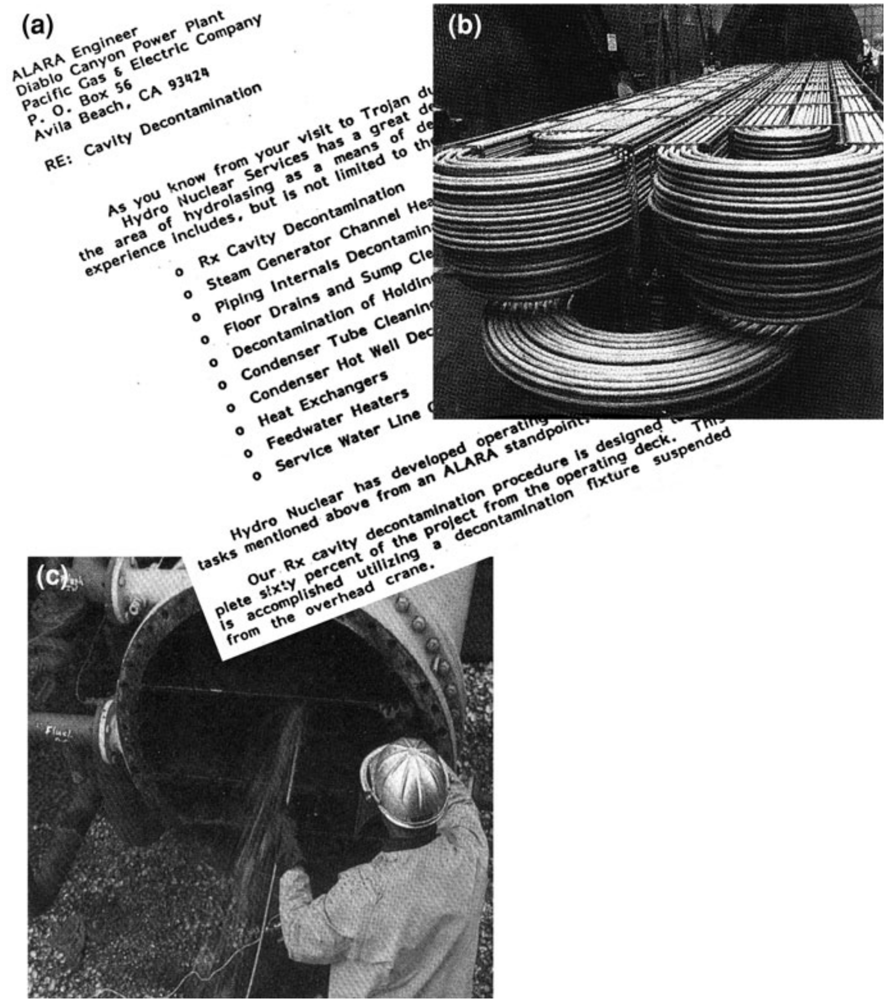


Fig. 3.155 **a**, **b**, **c** Power plant proposal, feed water heater, condenser

function. Most systems consist of a two stage reclamation process. Operating between 12 and 20,000 psi, utilizing comparatively low volume's at 5–16 gpm, with various automated stationary or rotating lance extensions operating jetting nozzles in repetitious and rotating configuration creating a milling process proved safe and successful. Explosive material is separated and macerated again by applying high-pressure water within a confined space. The water is recycled for further use in the jetting procedure. Filtration systems can be elaborate depending on explosives origination. The explosive constituent is disposed of in open burn or detonated on a firing range. This application does not belong to a contractor's curriculum but verifies the endless potential of high-pressure water as a tool.

GEAR - LIST AUTHORIZATION

Hazardous waste recovery, soil treatment, radioactive trace element remediation

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			
Nuclear power plant: Production tools: Treatment basins: Transportation vessels: Storage tanks: Rx cavity decontamination: Steam generator channel head: Walls: Uranium bars:		Immersing basins: Condenser hot well decontamination: Heat exchangers: Water intake screens: Cooling towers: Turbines: Feed water heater: Other:	
Decontamination: Radioactive material: Removing graphite deposits: Scale removal:		Pipe cleaning: Underwater pipe cleaning: Turbine cleaning: Other:	
Caustic soda: Aluminum oxide abrasive: Phosphatized degreaser: Demineralized water: Salt free water:		Chemicals: Other:	
In-plant hydro-unit and tools: Rx head shroud: Rigid lance: Pneumatic hydraulic rotating unit: Recoilless decontamination fixture:		Vise fixture: Metering injector: Metering pump: Other:	
Abrasives:	Grit size:	Pounds:	Explain:
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.			

GEAR - LIST AUTHORIZATION

Hazardous industrial waste, asbestos-ACM product removal

Customer & Company: Web site: e-mail:			Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:			
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:		Maintenance: Tel: e-mail:	Safety: Tel: e-mail:		
Job Description:						
Job Location:	Job Site Risk Assessment:		Specify:	©		
Job Review Performed by:						
Pressure washer: Hydro-blast equipment: Water recovery-recycle unit: Hydro-vac unit: Vacuum drums: Drum handling equipment: Air compressor: Disposable rags: Disposable protective gear: Polyethylene bags: six mil: Dump truck-roll-of box covered: Roll-off box, vacuum container: he			Enclosure material: (polyethylene) Plastic sheet role: six mill: two mill: Duct tape: 2 by 4 planks: Negative air space construction: Specify: HEPA vacuum filtration: Continues air flow monitoring: Respirator equipment: Specify: hi particulate air HEPA filtration: Personal protection gear: Specify: Step in-out area: Shower area: Clean room: Other:			
Hot water: Cold water: High-pressure trigger-gun: Flex-lances: Rigid-lances: Nozzles: 15° 20° : specify: gpm-psi Fog nozzle: gpm-psi Spatula: Rigid lance cleaning system: Foot valve: Other:			Chemicals: wetting agent: 50% polyoxyethylene ester 50% polyoxyethylene ether *Specify:* *MSDS:* T-dual cleaning head: Turbo nozzle heads: Rotary jet: Rust-inhibitors, metering equipment: Other:			
Product hardness, adhesion, viscosity:			*Specify:*			
Fouling characteristics:			*Specify:*			
Physical surroundings, safety procedures:			*Specify:*	Others:		
Describe application and work procedure:						
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.						

3.14 Hydrostatic Testing of Boilers-Steam Generators, Gas and Vacuum Vessels, Towers and Tanks, Pressure-Leak Testing Hydraulic Systems

This category also includes nondestructive tank testing of various shapes, design and purpose, including testing production systems which operate under pressure throughout the industrial and commercial environment. For example those tested are; high-pressure natural gas systems and tanks, oil–gas pipelines, various boilers-steam generators in power generating environments, towers, condensers, heat exchangers in production facilities such as refineries, chemical manufacturing complexes and their vessels-systems for various experimental, scientific and manufacturing prerequisites, etc. Hydrostatic tests (Fig. 3.156) can either be conducted under the constraints of industry or a customer's specification. The customer also must specify as to a nondestructive test as well as burst test.

An apparatus subject to positive (+) or negative (−) pressures including high temperature cycling or both will sooner or later need service or repair. Consequently a verification of its proper function is necessary activating a hydrostatic test procedure utilizing pressure-washing, hydro-blasting or UHP equipment (500–60,000 psi). The near incompressibility of water (0.05% at 10,000 psi) or oil is the preferred test liquid which is chosen for the detection of leaks or permanent changes in shape (deformation, cracks). Water is commonly used because of minuscule expansion in case of catastrophic failure to equipment being tested (only if unit tested is correctly purged of air-gas pockets). A penetrating wetting and/or preservation agent (polymer) can be metered to the fluid charge medium. Red or fluorescent dyes can also be added to the water-charge assisting in leak detection. For seams and welds a color developer can be sprayed on to suspect areas immediately identifying a leak. A discoloration remains visible, even if the leak dried overnight. Test pressures may range from 125 to 600% of equipments design pressure, and can be of classified nature concerning industry or military requirement.

Welding-repair procedures on vacuum, pressurized vessels (boilers-steam generators, condensers) and vessels subject to high heat temperature cycling will almost always present a hydrostatic test requirement scheduled by engineering or maintenance departments while in either progress of repair and/or after all maintenance efforts are completed.

To prevent bodily harm due to a catastrophic failure of any vessel tested, the operators location and distance from the vessel must be carefully determined (exceeding 500 gallons at 50 psi). Pressure washers or hydro-units should not be mobilized to fill and top-off industrial vessels. Water charge times exceeding 1 h should prompt the operation of a high volume-low pressure centrifugal pump (demanding an adequate plant water supply) or a hydrant supply if it is possible. In commercial and industrial environments the utilization of fire hydrants is most likely impossible. Water discharge on an automated fire suppression system will

JP TRANSPORT
INDUSTRIAL TRANSPORTATION SPECIALISTS

JOB REPORT
UNOCAL
WILMINGTON, CA.
JOB #

HYDROSTATIC TEST:
UNIT F204 AREA 60

EQUIPMENT USED:

HYDROBLASTER 66-B
VAN 300-V
2 HIGH PRESSURE HOSE ½ " 50' LONG WITH QUICK COUPLERS

HYDROSTATIC TEST EQUIPMENT:

FOXBORO CHART RECORDER. CALIBERED DATE
ROTARY CHART 0-2000 LBS.
VIKA PRESSURE GAUDGE (LIGUID FILLED) CALIBERED DATE
JP HYDROSTATIC VALVE ASSEMBLY
JP RV VALVE BOTTOM SET TO 1185 P.S.I.

PROCEDURE:

SET UP HYDROBALST UNIT 66-B
GROUND UNIT WITH RED GROUNDING CABLE
FILL VESSEL FROM THE BOTTOM WITH A TOP VENT
OPEN TO PREVENT AIR ENTRAPMENT
HYDROSTATIC CONTROL EQUIPMENT INCLUDING CHART RECORDER, MUST BE REMOTELY LOCATED TO PREVENT THE POTENTIAL FOR UNJURY IN THE EVENT THAT SOMEONE IS NEAR THE VESSEL AT THE TIME OF THE CATASTROFIC FAILURE. THE AREA AROUND THE VESSEL MUST BE CORDENT OFF WITH CAUTION TAPE AND FREE OF ALL PERSONNEL PRIOR TO PRESSURING BEYOND 50 P.S.I. JP RV VALVE SET TO 1185 P.S.I. PRIOR TO TEST. UNIT f204 PRESSURIZED TO 1135 P.S.I. WITHIN 20 MIN. RESPONSIBLE PARTIES CHECKED VESSEL AND THEN REDUCED PRESSURE TO 760 P.S.I. FOR ANOTHER 20 MINUTES. AT THIS POINT A VISUAL INSPECTION OF F204 VESSEL WAS MADE BY THE MAINTENANCE DEPT. AT THIS POINT "O.K." WAS GIVEN TO DRAIN VESSEL. VESSEL WAS DRAINED FROM THE BOTTOM WITH A VACUUM BREAKER AT THE TOP VENT, TO ELIMINATE THE POSSIBILITY OF CO_LAPSE DUE TO AN EXTERNAL OVER PRESSURE SITUATION.

Fig. 3.156 Customer's hydrostatic test specification

immediately activate a fire alarm and emergency procedure with varying intensity and/or no secondary verification. Hydrants may not always identify their water source or purpose in an in-plant situation. Also, charge water temperature and the method of water heating and temperature safety margins, or possible number of temperature cycles varies from job to job. Most contractors require a minimum charge (4-h), within a bid procedure. The nature of hydrostatic testing, especially field testing encourages maintenance departments to control mentioned application variables often with marginal success.

When stress and hold times, vessels fatigue criteria, and evaluation times of vessel components are an unknown and include the possible repetitive timing of charge water temperature cycles, pressure drop procedures for total system leakage analysis, and visual inspection between repair cycles, a contractors approximate time requirement must be established.

A typical in-plant work order description of a non-destructive test procedure as classified by plant engineer and maintenance department (Fig. 3.157).

Maintenance departments appreciate the written verification of test results by circular chart recorder for their keeping. Chart recorder test ports are most always identified by maintenance departments or field engineers. A contractor is wise to independently operate a currently calibrated recorder installed between the last ball valve assembly of the test manifold to vessel tested verifying his correct equipment function. The chart recorder is never applied or utilized to set or control

F-204 VESSEL/~~TOWER~~ HYDROTEST PROCEDURE, UNIT 60

- Install test blanks or blind flanges on all vessel openings.
- Hook up water fill and drain manifolds as shown on attached sketch:
  - Pressure indicators shown will be calibrated by Technical Crafts.
  - Pressure recorder will be provided by Technical Crafts and located remotely.
  - Water will pass through hot water mixer prior to entering F-204 vessel/~~tower~~. Operations to operate hot water mixer.
  - A temperature indicator will be located on the vessel to insure minimum water temperature is maintained.
  - R.V. on bottom set to 1185 psig (25-50 psig greater than test pressure.)
- Hydrotest water temperature shall be not less than 70°F. and not more than 120°F.
- The vessel shall be filled from the bottom with a top vent open to prevent air entrapment.
- The vessel shall be drained from the bottom with a vacuum breaker at the top vent to eliminate the possibility of collapse due to an external overpressure situation.
- Pressure control equipment including the chart recorder shall be remotely located to prevent the potential for injury in the event that someone is near the vessel at the time of catastrophic failure.
- The area around the vessel shall be cordoned off with caution tape and free of all personnel prior to pressuring beyond 50 psig.
- The F-204 vessel/~~tower~~ shall be pressured to 1135 psig and held for a minimum of 15 minutes and until responsible parties from Operations, ME&I, and Maintenance Departments are satisfied. The pressure shall then be reduced to 760 psig. The reduced pressure shall be at least 2/3 of the hydrostatic test pressure (ASME BPVC Section VIII P71). At this point a visual inspection of F-204 vessel/~~tower~~ will be made. When all interested parties are satisfied, the pressure will be relieved and F-204 vessel/~~tower~~ drained.
- Pressure chart to go to ME&I.

Fig. 3.157 in-plant work order

Fig. 3.157 In-plant work order

equipment test pressures. Often, on a weekly basis, contractors will lease mechanical or digital stripe-circular chart recorders and confirmable calibrated in line water volume-psi metering-sensor devices, with an accuracy of ±1 psi to eliminate the otherwise on-site problematic verification of equipment calibration.

On this note, most contractor services are required because they provide the necessary equipment capability in adequate psi–gpm and if possible water heating performances. They are not hired to take responsibility for varying test procedures or results. Technical aspects are always controlled by hardware owner or their maintenance personnel. Nevertheless it is important to understand the technical aspects encountered facilitating a correct proposal procedure.

When filling a vessel always use the lowest pipe flange of the unit to connect water supply hoses, which in some instances will avoid air entrapments (not guaranteed). The vessel's top ventilation must be sufficient and located on the highest point of the internal–external structure to avoid air entrapment. Sometimes the ventilation valve assembly is too narrow to accommodate the air displacement (circumference ∅) created by the water feed to the vessel, subsequently pressurizing before the test procedure begins.

When test water–oil is drained (through the unit's bottom) adequate ventilation must be guaranteed (air volume) to prevent a catastrophic cave-in event. Top tank ventilation must by open first and locked-out before a fluid draw can begin. Rushing water–oil masses can create near-max vacuum conditions capable of destroying most vessels encountered. To protect against a system failure (overpressurization) a liquid-filled pressure gauge and a RV valve (pressure relief valve) set at 5% above max test pressure, is affixed to vessels bottom and top vent assembly. Vessel damage is also possible if the RV valve value does not accommodate the full flow-volume produced by either the pressure-washer or hydro-blast pump equipment. A multitude of pressurizations are common, especially when testing large units such as steam-generators, tanks or pipeline systems where maintenance problems occur during welding procedures, or sectionalized quality assurance tests are performed.

Around-the-clock standby requirements are frequent; therefore a standby fee is negotiated. During pressurization, maintenance personnel should check for existing leaks at predetermined intervals. If no leaks are detected the desired pressure will be maintained according to the hydrostatic schedule. When applying oil as test medium and ambient temperature fluctuations are possible operators must compensate for the typically elevated contraction or expansion of oil (liquid hydrocarbons) otherwise resulting in a psi fluctuation limiting precise test results. As with high-pressure water hose assemblies, significant pressure variations can be encountered due to weather-temperature cycling when in a static pressurized water–oil charge (direct sunlight). This complicates test procedures especially when long-term static pressures must be maintained (adding-bleeding).

By activating the dump-meter valve the pressure drop may be stopped as desired and maintained at its present level by closing ball valve #6. Reducing pressures totally by regulating dump-metering valve until the gauge on the vessel and chart recorder measure or indicate the remaining natural static pressure within unit. The minor compressibility of water (0.05% at 10,000 psi) results in a quick depressurization which also indicates that air pockets are not present in the unit's interior. Once the test procedures are completed, and only static pressure remains, first open top vent and secure valve's open position before discharging the test water through the unit's bottom. Again, this is imperative to prevent vessel damage (Fig. 3.158). Also a site-specific NPDES discharge permit is required for hydrostatic test water released to ground or storm water system. Barricade tape must restrict all traffic in essential areas including the predetermined test site of hydroblast equipment operators. Converting a pressure washer or a hydro-blast unit to a full-fledged hydrostatic test apparatus is inexpensive, simple and does not

Fig. 3.158 Tank-vessel damage by vacuum

Fig. 3.159 Hydrostatic test manifold

constitute a major technical change. However, units with governors controlling the engine's rpm while pressurizing their system will need a changeover to a manual rpm control, and in some cases a pressure regulator and adjustable safety valve must be added. To correctly analyze gpm performance a digital turbine flow meter can be added to the test manifold. Pipeline operators and plant maintenance engineers, may follow guidelines set by the American petroleum Institute recommended practices, 1110, testing of liquid petroleum pipelines, state code regulations for marine terminal oil-pipelines, department of transportation, DOT 49 CFR part 194, testing of hazardous liquids pipelines, American society of mechanical engineers, B31.4 testing pipeline transportation systems for liquid hydrocarbons and other liquids.

There are eight major components allied to a test manifold (Fig. 3.159), which will permit the flexibility necessary for various test environments and enforced regulatory provisions:

1. The pump's pressure gauge directly verifies the desired test pressure and indicates the actual psi developed when the pressure regulator is adjusted.
2. The pump's pressure regulator is set to the max hydro-test requirement. The pressure is formed by closing the dump-metering valve # 3 and ball-valve # 5, thus permitting the produced water to bypass the pump regulator. The volume

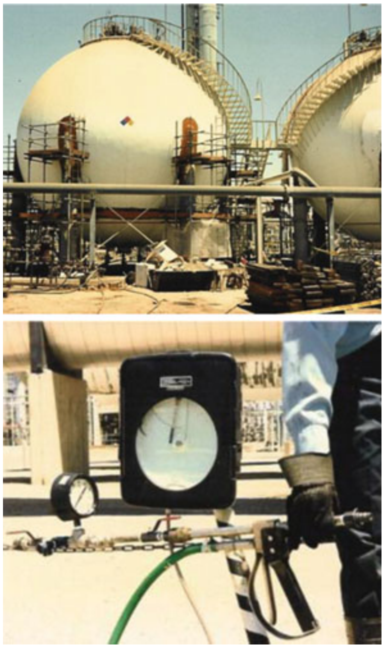


Fig. 3.160 **a** Test vessel, **b** chart recorder

of the water-feed is determined by the pump's rpm and is adjusted to the circumstances involving the encountered vessel's air pockets.

3. There is a design similarity between the operating dump metering valve and the dump gun #3 which permits the utilization of most dump guns, however, the dump metering valve does not feature a pressure-balancing orifice on the dump side of the valve (removed) nor a nozzle component. This valve provides total control when a manual trigger activated pressurization permits a feel for timing and an optical physical volume control when gauging the excess water, leaving the bypass orifice while metering smaller water amounts to the vessel, regardless of engine's-pump rpm produced. Over or accidental vessel pressurization is therefore impossible.
4. The pressure relief valve (RV valve) is set slightly above test pressure (max +2%). The valve must be sensitive and completely discharge the produced pump water volume (gpm) and when activated under any circumstance eliminate a further vessel charge.
5. The ball valve is activated to maintain the static pressure in the vessel being tested #6. In case a vessel pressure drop occurs it is suggested to close ball valve #5 to double-check valve #6 for leaks, which can be identified by possible difference indicated by vessels' pressure gauge and test manifolds chart recorder #7.
6. The amount of water added to the vessel while charging can be determined by reading the turbine flow meter. When operating the dump metering valve the

GEAR - LIST AUTHORIZATION

Hydrostatic testing of boilers-steam generators, tanks pipelines, gas and vacuum vessels

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: State:	P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			
Tanks: Pipelines: Tubing: Test Vessels: Steam Generators:		Steam generator-boilers: Heat exchangers: Gas tanks: (industrial) Oxygen tanks: (industrial) Other:	
Pressure washer: hot: cold: Hydro-blast unit: “ “ Centrifugal charge pump: Test equipment: (calibrated) Turbine flow meter: (calibrated) Chart-recorder-digital: (calibrated) Tracer concentrate: Fluorescent: Surface tension reducer:		Heated test water: *Specify: F° -° +°* Cold test water: *Specify:* Charge water pressure: Barricade tape: Other:	gpm: psi:
In-plant testing:			
Static pressure difference (+,-) from bottom of unit tested:			
Test equipment distance from tested vessel:			
Safe test area location: *Specify:*			
Systems failure protection RV valve:		RV- valve assembly: (calibrate)	
RV valves volume capability: *Specify:*		*(calibrate)*	
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.			

3.14.285

water volume loss due to possible system leaks is also projected. The chart writer records the gpm added to the vessel (if so desired).

7. Pressure-sensitive chart recorders (Fig. 3.160b) are vulnerable to shock, vibration and pump cycles. Install a dampener to produce a smooth chart printout. This unit protects the recorder, especially when the operator abruptly controls the dump metering valve.

GEAR - LIST Nr.

Customer & Company:

Web site:
e-mail:

Date:
Address:

Job Nr.:

City:
State:

P.O. Box:
Zip Code:

Purchasing:	Engineering:	Maintenance:	Safety:
Tel: e-mail	Tel: e-mail	Tel: e-mail	Tel: e-mail

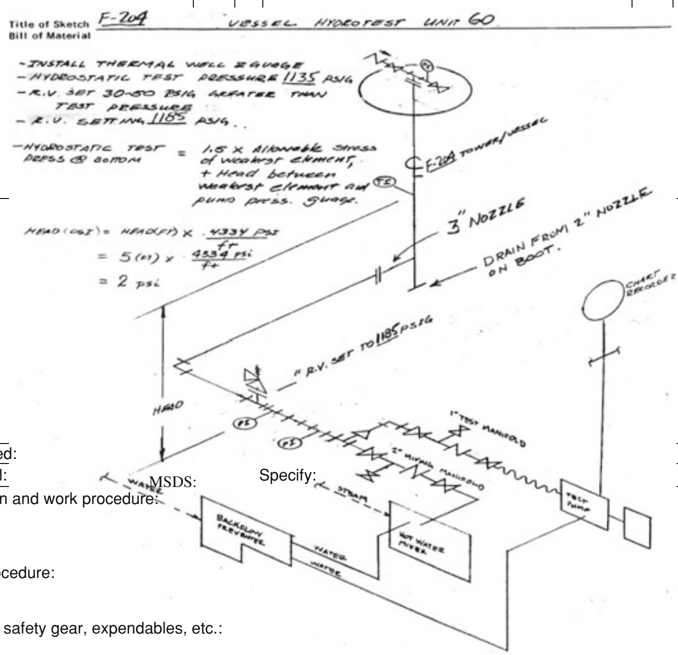
Job Description:

Job Location: Job Site Risk Assessment: Specify: ©

Job Review Performed by:

Plant hardware: Hydro-blast equipment:

Hydrostatic test of Vessel 204



Plant location:
Product encountered:
Hazardous material: MSDS: Specify:
Describe application and work procedure:

Describe safety procedure:

Itemize equipment, safety gear, expendables, etc.:

Fig. 3.161 in-plant work order

8. The ball valve #6 may isolate the test equipment and in doing so, not interrupt the test procedure. This also permits exchange of chart paper, adding or exchanging faulty equipment or resetting RV values as desired.

The static pressure difference (±) between the test equipment's location and the bottom-center to top of vessel most always be included (Fig. 3.161). Customers

sometimes require the installation of an in-house tested pressure gauge to the test manifold #4. Contractors interested in this application may also rent this equipment (complete test manifold) in its entirety. Customers require calibration dates and functional guarantees, which most rental companies provide and renew. Financially this application is lucrative and deserves aggressive salesmanship. Pressure washers-hydro-blast, and UHP equipment units from .500 to 55,000 psi are standard.

3.15 Mold Remediation, Disaster Cleanup, Water Damage-Sludge Removal, Insect–Pest Suppressio, Odor-Stench Control

Wind, water, fire or the combination of all three provide a business potential for honest and experienced contractors specializing in disaster cleanup, restoration, mold remediation, odor-stench control and insect–pest suppression. The situation at hand is all too often exacerbated by opportunistic start-ups and/or fly-by-night service companies further victimizing the disadvantaged property owners. Under these circumstances is it important to verify a restoration contractors credentials. Due to the multiple varieties of encountered problems within this application criterion, a contractor must have a minimum of 3 years experience. His membership to a trade association may help to verify competent past professional performances. Verifying recommendations of past customer and involved insurance carriers and adjusters, proof of current liability insurance of 2 million dollars and carrying workers compensation insurance for all employees is a identifiable criterion a customer should acquire to before a job walk is initiated.

All of the available pressure washing and hydro-blast tool combinations are utilized within this application criterion. Cleaning and remediation techniques are paired with chemical treatment concerning molds, odor-stench controls and insect–pest suppressions. Removing, packaging and transporting of various hazardous materials can require a qualified HAZMAT team, to prevent further contamination by bio, asbestos or lead containing materials as is the correct identification of harmful substances, important within a disaster cleanup procedure, varying with every incident.

The fire and smoke damage restoration (Figs. 3.162, 3.163) of wood façades (stain) by high-pressure water is an application which will most often result in a rustic look sometimes astonishingly beautiful compared to appearance prior disaster. Material can be removed to the damaged interface zone, stains treated and burned coatings can be removed. There is a certain possibility as to a customers suggestive perception concerning final façade appearance. This can best be controlled by providing test patches, which might require a staining or coating procedure. Best results are achieved utilizing not more than 2.5–4 gpm and most important the use of high-end precision fan nozzles at pressures up to 3,000 psi.

Fig. 3.162 Fire damaged wood

Fig. 3.163 Fire damage removed

Fig. 3.164 Mold remediation

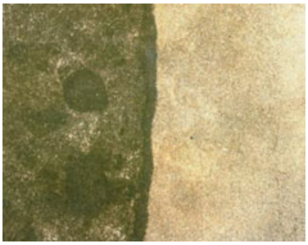


Fig. 3.165 Mold, before–after

Fan nozzle degree will be chosen by severity of damage encountered, wood age and its type. The nozzle standoff distance will be adjusted as to the friability point of woods damaged interface.

Mold remediation (Figs. 3.164, 3.165, 3.166) following a disaster cleanup is a common occurrence, especially in humid environments. This manifestation can be explosive when past cleaning procedures did not entertain a final rinse cycle introducing a variety of antifungal and mold suppressants. Chemistry chosen must

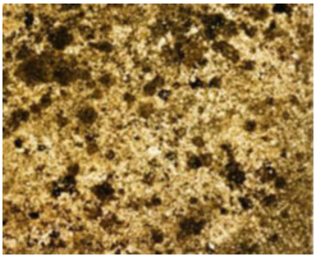


Fig. 3.166 Undisturbed mold on concrete surface

Fig. 3.167 Chem. feed pump

also consider the present environment and its natural spore's habitat transmitted by air current. Humidity, faulty structures and uncontrolled vegetation-undergrowth, combined with sun starved surfaces makes for a perfect environment, especially when surfaces in question provide an organic food supply besides moisture. Mold can appear on most substrate and does include wood, concrete, sandstone, limestone, cinder-block (CMU) infestations and brickwork in short, most porous surfaces are susceptible to these windswept transmitters or developments and can be as simple as a transference from a nearby infested cedar shingle roof provided by favorable conditions. Inadequate remediation procedures can often be linked to a missing microbial analysis by a qualified environmental diagnostic laboratory. There are substantial differences between moss and mold developments.

Odor-stench control is best achieved by removing the source of its development. If possible, the utilization of hot high-pressure water is of a definite advantage. Once odor causing materials are removed and all surfaces are dry an odor neutralizing chemistry and/or materials are available to absorb, neutralize and disinfect areas of displeasure. An active ingredient such as stabilized chlorine dioxide can be quite effective. A variety of fire/odor control products are available, but must be met with skepticism. Besides, chemical treatment there are also industrial solutions, which utilize atomizers which can also be applied for dust suppression requirements (Fig. 3.167).

Fig. 3.168 Ant–pest control

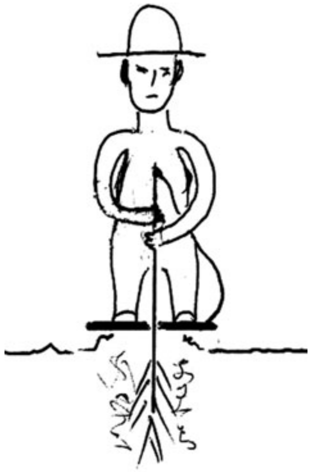
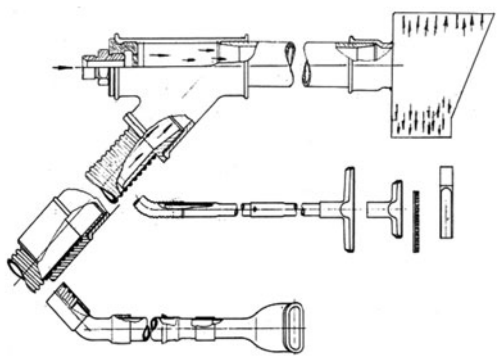


Fig. 3.169 Hydro-vac unit



The professional water damage–restoration contractor utilizes modern diagnostic equipment, which includes penetrating and non-penetrating moisture meters, digital hydro meters, combined with state-of-the-art infrared thermal imaging cameras utilized to detect damage and moisture pockets in cavities throughout various levels of an affected structure. Applying necessary drying and dehumidification equipment and providing a qualified labor force is of utmost importance as is the correct application chemistry, which is best followed precisely as to manufacturers identified application criteria.

Insect–pest suppression requires the penetration of their hiding place by high-pressure water combining water velocity with chemistry and/or heat. Cleaning surfaces first and concentrating on crevices and cracks, possibly containing fungus and pests, utilizing hot (above 200°F) water can greatly reduce the otherwise necessary volume of pesticides and their penetration-dwell time. In open or confined spaces a precise pesticide metering process to any hot or cold pressure washer unit is quite an effective weapon and especially useful in the agricultural environment.

GEAR - LIST AUTHORIZATION

Mold remediation, disaster cleanup, sludge removal, pest suppression, odor-stench control

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Fire damage: Water damage: Wind damage: Vehicle accident: Crime scene: Other:			Chemistry: Specify: Chemical injector: ratio: Specify: Turbo nozzles: Vacuum supported spin jet: Vacuum supported floor cleaners: Water recycling equipment: Other:		MSDS:
Pressure washer: hot: cold: Hydro-blast unit: " " Jet vacuum-pump: 2" 4" 6" Vacuum hose: Specify: Vacuum tools: Specify: High-pressure hose: Specify: Other:	gpm:	psi:	Safety gear: Specific-specify: Respirator: Microbial analysis: Bio-remediation: Mold removal: Odor-control: Specify: Pump-up chem. sprayer: Electric pump barrel applicator:		
Hazardous waste removal:			Specify:		

Permits:			
Hazardous waste site:			
Tank truck:	Roll-off box:	Specify: 20, 40, 60, yards: open-closed	
Mud dump site:			Mud evaporation bed:
Dehumidification equipment:	Moisture-meters : penetrating (non)	Infrared thermal imaging:	
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.			

3.15.290

GEAR-LIST Nr.

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: State:	P.O. Box: Zip Code:
Purchasing: Tel: e-mail	Engineering: Tel: e-mail	Maintenance: Tel: e-mail	Safety: Tel: e-mail
Job Description:			
Job Location:	Job Site Risk Assessment:		Specify: ©
Job Review Performed by:			
		Chemistry:	
Laboratory:		Equipment: Expendables:	
Product encountered:			
Hazardous material:	MSDS:	Specify:	
Describe application and work procedure: Describe safety procedure: Itemize equipment, safety gear, expendables, etc.:			

3.15.291

In open space, utilizing a hot pressure-washer (200°F plus) applying a trigger gun and 6-ft wand fitted (Fig. 3.168) with round jet and a circular ant-guard with center lance access and plate retainer quickly permits the destruction of the fire ants queen and her eggs which are placed deeply in a mounds habitat. Sounds brutal, but it is a much better solution than applying or injecting hazardous poisons into the soil (least environmental impact).

Sludge removal due to flooding emergencies, and associated mud-sedimentation or pumping water up to 100 gpm (20 hp) in any area of affected buildings can best be serviced by utilizing a mobile commercial hydro-vac unit (Fig. 3.169) utilizing between 20 and 45 hp. Equipment services can be offered immediately because their function does not depend on a foreign power source and only requires a water feed which may be flood water in itself. A 20 hp input may service a radius of 400′ at near-max vacuum performance. The immense advantage is the systems light weight and mobility, where application flexibility may be tested minute by minute (always beneficial in an emergency situation). Water and/or mud-sedimentation transfer and possible receiving locations or containers can be a fluid scenario as required by the emergency. Jet vacuum-pumps can be installed strategically between a 2″ and 200′ vacuum-hose assembly by removing the recoil box or with recoil receiver directly placed to any desired dump site discarding water and mud sediment. Automatic draw can be installed by utilization of engine start floats. Functional, equipment can be delivered to any site where a quarter ton pickup truck can operate. Due to the high vacuum and associated air volume performance, tightly adhered mud accumulations are easily removed, liquefied and pumped or discarded to an available evaporation site. Jet pumps and their available accessories cannot prevent a disaster but are unmatched in their application potential for remediation-cleanup procedures (industrial performance). IICRC storm damage, restoration recommendations, http://www.certifiedcleaners.org. American Bio-recovery Association, http://www.americanbiorecovery.com. EPA, fire response and recovery information.

3.16 Oil Lube Systems (Industrial), Tanks, Oil Compressors, Hydraulic Equipment Services, Light Oil Jetting

Oil lube systems are designed to lubricate main turbine bearings, compressor gear ends, pump–piston areas and blower bearings, in short, any type of machinery under constant load using oil at a set operating temperature and pressure. In general, this is achieved by circulating turbine oil throughout a unit's load bearing system. These systems, as such, consist of a pump, filter screens, metering valves, thermostats, oil lube coolers, pressure-regulating devices and a main oil lube tank.

A contaminated system can prove costly to power plants, refineries and chemical plants (bearing, valve, fragments and corrosion). Contamination may arise by circulating fatigued bearing materials such as aluminum, cast iron and steel particles. Rust development and subsequent scale contamination which has developed in steel supply and discharge lines may be the result of condensed water admixed with turbine oil. Other culprits include a higher oil viscosity and plugged filters resulting in filter screen ruptures, allowing contaminated oil to circulate freely throughout the system, and thus accelerate bearing, cylinder and o-ring wear.

Fossil fuel and nuclear power plants are quite familiar with hydro-blast and high-pressure oil cleaning methods. There it has been proven and accepted by turbine manufacturers as being far superior to the generally-applied oil flushing method, which circulates vast amounts of heated, filtered turbine oil through the oil lube system, removing debris in compressor cavities, bearing housing and pressure discharge lines.

Most maintenance engineers in refineries and chemical plants have yet to be exposed to this proven hydro application and are therefore considered prime customers for contractors and hydro-manufacturers alike.

Contractors interested in this field should regard this application as a separate identity from their daily pressure washing routine. To achieve a convincing and sound technical background, technicians and salesmen should familiarize and specialize themselves in this global application. An added investment of approximately $2,500 in accessories, minor when considering potential income prospects, will be necessary to allow a complete service capability. Having to replace a corroded oil lube system is far less cost-efficient than employing a contractor at $300 an hour to recondition the system by returning it to full operational status within 24 h.

In the mid 1970s, WOMA Corp. tested this application successfully at a major power plant facility in Arizona, setting the first vital technical parameters. Demineralized water was then applied to effortlessly remove corrosion from oil supply and discharge lines and included rust, sediment and gasket debris removal exceeding all achieved expectations and long-term operational status.

Applying this technology in the United States resulted in varying opinions. Some engineering and maintenance identities feared most commonly the practice of applying demineralized water in their oil lube systems. This prompted the changeover to compatible light oil as a blast medium which proved favorable. The drying procedures of oil lube systems were eliminated, and with it, removing the possibility of water pocket formations. The nozzle's standoff distance is tremendously enhanced because of the oil molecule structure, which optically appears similar to polymer blasting, creating a higher nozzle impact, and thus allowing for applying equipment operating at 1,500–4,000 psi. The gpm performance may vary as to nozzle configurations applied. This light oil jetting application was immediately preferred and resulted in a common understanding.

Confined application-related oil spillage can be allowed in most refineries; their recovery systems are well equipped to handle the low volume, eliminating further environmental problems. When utilizing this light oil jetting application in power plants and most chemical plants, circumstances are quite different. The blast oil must be considered a commodity purchased by either the contractor or customer. Spillage cannot be accepted under any circumstance, forcing a totally confined cleaning and oil recovery method (Fig. 3.170).

The vacuum recovery unit, consisting of a quick-connect pipe flange coupler, providing a flex lance guidance system, is ideal for this type of oil jetting application. The flex lance guiding system also incorporates a vacuum hose connection.

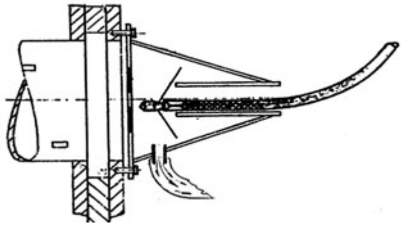


Fig. 3.170 Oil recovery tool-flange

Product-Application Sheet

Union Turbine Oil

union 76

GENERAL

Union Turbine Oil is a rust and oxidation inhibited oil designed for use in applications requiring a good quality inhibited oil.

Union Turbine Oil is recommended for use in hydraulic systems, steam and hydraulic turbines, circulating lubrication systems, industrial gear sets, air compressors, and a wide variety of other industrial applications.

DESCRIPTION

Union Turbine Oil is made from solvent treated lubricating oil base stocks manufactured from selected crudes.

Inhibitors are added to improve resistance to oxidation and to protect metal surfaces against rust and corrosion under severe operating conditions.

MEETS SERVICE REQUIREMENTS:

Cincinnati Milacron P-38 Light Hydraulic Oil—Union Turbine Oil 150.

Childers Manufacturing Co., Inc. Heat Transfer Fluids.

TYPICAL INSPECTION TESTS:

Grade, ISO	22	32	46	68	100	150	220	460
Former ASTM	105	150	215	315	465	700	1000	2150
Product Code	4620	4621	4622	4623	4624	4625	4626	4627
Density g/cm³ @ 15 °C	0.8741	0.8799	0.8839	0.8895	0.8934	0.8979	0.9014	0.9071
Gravity °API	30.4	29.4	28.7	27.6	26.9	26.1	25.5	24.5
Color ASTM	1.0	1.0	1.0	1.0	L2.5	L5.0	L6.0	L7.0
Flash Pt. COC °C(°F)	212(414)	212(414)	230(446)	244(471)	254(489)	260(500)	279(534)	299(570)
Fire Pt. COC °C(°F)	234(453)	240(464)	252(486)	264(507)	276(529)	280(536)	296(565)	318(604
Pour Pt. °C(°F)	-30(-22)	-20(-4)	-24(-11)	-18(-4)	-9(16)	-9(16)	-9(16)	-9(16)
Aniline Pt. °C(°F)	93(199)	96(205)	99(210)	102(216)	103(217)	106(223)	109(228)	113(235)
Viscosity								
SUS @ 100 °F	114	157	209	336	495	756	1,113	2,352
SUS @ 40 °C	104	143	189	299	439	663	968	2,020
cSt @ 40 °C	21.7	30.4	40.6	64.5	94.8	143	209	436
SUS @ 210 °F	40	44	48	53	62	72	87	132
SUS @ 100 °C	40	43	47	52	61	70	84	128
cSt @ 100 °C	4.07	5.23	6.47	8.00	10.57	13.0	16.6	26.7
Extrapolated Vis @ -18 °C SUS	5,045	7,881	—	—	—	—	—	—
cSt	1,095	1,711	—	—	—	—	—	—
Viscosity Index	73	102	109	88	93	81	81	83
Neutralization Number	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Ash Dry Wt%	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Carbon Residue, Rams Wt%	0.07	0.07	0.07	0.07	0.20	0.25	0.3	0.4
Sulfur Wt %	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Copper Corrosion 3 Hrs @ 100 °C	1a	1a	1a	1a	1a	1a	1a	1a

Fig. 3.171 Light oil product application sheet

The vacuum hose delivers contaminated oil to the holding tank, separating coarse contaminants efficiently.

From this point, a high volume 5 µm oil filter (or greater) rids oil of finer contaminants for recycling to oil heating unit which is locked in between the filter

Fig. 3.172 Splash guard

assembly and suction tank of the hydro-unit directly delivering blast oil (Fig. 3.171) again to the job site. This system has also proven highly successful when water is a substitute for light oil in all other pipe cleaning facets where the cleaning process must not contaminate the direct surroundings by product or water splash poses an environmental or a health threat. Retrieved materials or contaminants can also be discarded into tank trucks or any vessel, thus allowing the reuse of water or blast medium. An assortment of lance, and flex lance vacuum retrieval systems are available and can simply be modified to most applications. Adjustments are performed on the jobsite with plant maintenance.

When large H_2O compressors and their like are serviced or are reassembled at their place of operation, further contamination in the compressor's interior cannot be avoided, or at best, not guaranteed. A last low-pressure wash-down using a compatible light oil is highly recommended before the final system flush is performed, especially in the unit's low velocity cavities where entrapment of contaminants are practically guaranteed. Accessories used include a combination of ¼″ trigger gun extensions fitted with quick couplers ranging from 3′ to 6′ in length, bearing a 20° fan nozzle and not larger than .060 or 1.5 mm diameter orifice. The second lance presents a T configuration, equalizing nozzle recoil forces and allowing cleaning procedures in inaccessible areas. The third lance is a 6′ long, ½″ aluminum pipe fitted with a flex lance and a nozzle featuring two orifices at 45°, capable of reaching and cleaning cylinder sleeves, oil intake lines and other inaccessible areas. This aluminum tube must contain a locking device preventing possible lance extraction. A two-man operation is best suited for this procedure; one holding and controlling the aluminum tube and the other controlling the foot valve or hydro trigger gun and lance travel necessary.

Disassembled oil lube coolers are cleaned by the usual hydro-blast method using the vacuum recovery system. In place oil lube coolers located and integrated

in vertical positions such as generator turbines are nowadays serviced utilizing a drip proof splash guard unit (Fig. 3.172), which provides a three-lance operation, cleaning six to nine tubes a minute and returning blast medium to the discharge side of the cooler located below the turbine generator area. These open drip-proof units are also used on all vertical exchangers and condensers, providing an ultra-safe and dry cleaning method at the rate of six to nine tubes per minute. The application requires pump performances from 1,500 to 9,000 psi at 5–16 gpm.

GEAR - LIST AUTHORIZATION

Oil lube systems, tanks, oil compressors, hydraulic equipment services, light oil jetting

Customer & Company: Website: e-mail:		Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:		Specify: ©
Job Review Performed by:			
Oil lube cooler: Main oil lube tank: Oil supply pipes: Oil discharge pipes: Turbine generator: Condenser:		Heat exchangers: Secondary oil tank: Filter screens: H2O compressor: Low velocity cavities: Cylinder sleeves: Other:	
Scale debris type: bearing-gasket, corrosion, water condensation Other:			
Environment:	Industrial:	Commercial	Residential:
Equipment: Drip-proof splash guard unit: Vacuum recovery unit: 5-Micron oil filter: Oil heating unit: Tank truck: Oil tank: (500 gallons) Vacuum hose: (2” 4”)		Flex Lance: Aluminum Lance Guide: Rigid Lance Extensions: (4’.) T-Lance: (5’.) Foot Valve: Flex Lance: Other:	
Blast fluid specification: Return oil to production process: Discard oil: Turbine oil:	Specify:	Explain Method: Turbine Oil Grade: Specific Weight: Other:	Viscosity: Flammability:
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.			

3.16.294

GEAR - LIST Nr.

<table>
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Web site:
e-mail:</td><td colspan="3">Date: Job Nr.:
Address:

City: P.O. Box:
State: Zip Code:</td></tr>
<tr><td>Purchasing:

Tel:
e-mail:</td><td colspan="2">Engineering:

Tel:
e-mail:</td><td>Maintenance:

Tel:
e-mail:</td><td colspan="2">Safety:

Tel:
e-mail:</td></tr>
<tr><td colspan="6">Job Description:</td></tr>
<tr><td colspan="6">Job Location: Job Site Risk Assessment: Specify: ©</td></tr>
<tr><td colspan="6">Job Review Performed by:</td></tr>
<tr><td>Plant hardware:</td><td></td><td></td><td>Hydro-blast equipment:</td><td></td><td></td></tr>
<tr><td>Plant location:</td><td></td><td></td><td>Equipment:

Expendables:</td><td></td><td></td></tr>
<tr><td colspan="6">Product encountered:</td></tr>
<tr><td>Hazardous material:</td><td>MSDS:</td><td></td><td colspan="3">Specify:</td></tr>
<tr><td colspan="6">Describe application and work procedure:

Describe safety procedure:

Itemize equipment, safety gear, expendables, etc.:</td></tr>
</table>

3.16.295

3.17 Ornamental Statuary–Monuments, City Fountains, Theme–Amusement Parks, Hotel–Municipal Pools, Aquatic–Marine Pools and Tanks

Statuary and monuments in cemeteries, city parks, on street corners and the occasionally displayed art pieces in town centers or open areas of interest (museums, etc.) are subject to weathering, soot-soiling and various bio-contamination caused by birds and humans. Undoubtedly one of the most famous and probably technically attractive cleaning solutions was provided by Kärcher, C-Tech Industries on the national monument in South Dakota (Fig. 3.173), and the statue of Christ the Redeemer in Río de Janeiro, Brazil. Judging by various South Dakota technical reports the application aspects were intriguing due to the fact that the necessary water had to be delivered to a mobile tank unit installed above the rock statuary fascia supplying the hot water pressure washing equipment by transfer pumps. Commercial climbers were confronted with excessive hose length, which had to be controlled, avoiding hindrance when cross walking substrates fascia. The accumulative water mass resulting from excessive hose length also required the utilization of trigger-guns and hose armatures capable of withstanding water velocity and its resulting pressure peaks in operators' vicinity. This can also be achieved by incorporating the pressure activating valve within the pressure regulator assembly at or near the unit's pump head. This type of pressure activation may also reduce momentary start up recoil forces upon the climber. The monument, being granite, offered some growth of moss in crevices, discoloration resulting from bio residual and water leaching downward of fascia and crevices filled with various caulking and adhesives installed by national park rangers in their attempt to control damage by freeze–thaw cycling on all important surface structures.

The cleaning itself was performed by utilizing turbo-nozzles providing a sharp edge and wide cleaning coverage. The hot water supported disruption of organic root growth, while jetting crevasses clear off various nourishment-soils diminishing future growth activities. After removing remaining loose or deteriorated caulking products, crevices susceptible to freeze thaw cycling were sealed. Due to the monuments remote location, a timeline of gigantic proportions had been established by Kärcher. Untouched by high-pressure water the remaining mountain substrate will in the future educate as to the severity of an environmentally introduced surface contamination and influence by freeze–thaw cycling in comparison to all surfaces successfully cleaned. Park rangers, scientists, restoration–preservation specialists, pressure washing and hydro-blast equipment manufacturers alike will learn a great deal within the next 20–30 years as to the positive influence affecting granite surfaces treated by high-pressure water and the visually achieved longevity of its beautification by a high-pressure jetting procedure.

Granite and architectural marble cleaning and conservation is safely achieved when utilizing high-pressure water either with fan jets or turbo nozzles with

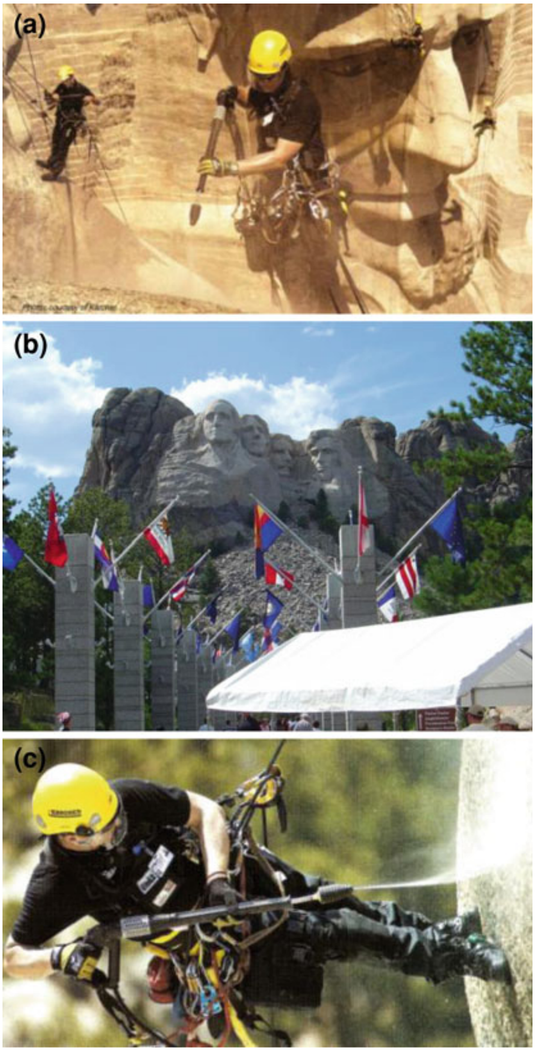

Fig. 3.173 **a**, **b**, **c** National monument

pressures ranging between 1,000 and 3,000 psi at 2.5–5 gpm hot or cold water without the loss or dulling of existing surface gloss. Most often faded gloss or damage occurs due to pedestrian shoe sole abrasion and environmental impacts that more often than not has been accelerated by improper use of harsh chemicals, failing neutralizing chemistry and inadequate buffing compound applications. The high-pressure water pre-cleaning is particularly effective when introduced to a failing stone gloss prior to a restoration and maintenance procedure. It is especially effective in removing aggressive sharp edged tiny contaminants (silica, etc.) embedded in the gloss seal interface most often introduced by substandard cleaning and seal applications.

These abrasive contaminants can be responsible for edge-swirl marks when buried into pads of buffer-polishing equipment. Stone specific honing compounds are utilized in a measured application criterion, which cannot be compromised by irregular supply and/or unidentified product contamination.

Marble is a crystalline compact variety of metamorphosed limestone. This sometimes is the reasoning by which restoration and preservation specialists nix high-pressure water as a cleaning tool. Often these are the same specialists which will apply a 50–50 water chlorine bleach solution, and combine this with light or heavy brushwork on historic substrates. Neutralization of chemical remnants is mostly marginal and performed with flushing water to a possible porous stone substrate. Applying household vinegar to surfaces in question completes their service cycle. This inadequate circumstance is often enhanced by failure to correctly categorize various stone substrates and the identification of why a cleaning procedure is necessary. Besides making use of abrasive blast techniques this behavior has through the years permanently damaged sensitive stone statuary, building façades and architectural components. As many antiques have been destroyed or lost their antiquity value by incompetent cleaning procedures, as has the conversion or destruction of an aged look or beautiful patina on various stone and metallic substrates, destroyed art or architectural heritage structures, façades and statuary. By the way, these methods also accelerate the usual damaging manifestation by environmental influences which are especially noticeable when competing for work in established cemeteries.

The disparity of deteriorated old markers, granite, lime and sandstone or variations of damaged slate stone and concrete units can be impressive as to their state of physical decline, which often also identifies past harmful cleaning–restoration scenarios. These stone credentials also absolve the high-pressure water cleaning technique, simply because the gravestone cleaning application by high-pressure water as a tool was at best limited or only available in very few regional areas. Especially when considering the mobile pressure washing industries state of existence and equipment ability–mobility 40 years ago. Therefore a hobby historian's opinion must be viewed critically as to the creation of long-term damaging effects which cannot be established by anyone regardless of education or application knowledge. Damage and deterioration are more often than not the result of services indifferentism to varying substrates which will change with every memorial-internment site.

For business prosperity is it wise to establish and submit to the job walk report a digital photo history of a project at hand (Fig. 3.174). Identify foliage condition around internment site, possible existing damage to stone surfaces or base structure which includes identifying obvious friable stone-face surface conditions and lettering, readily falling away grainy–sandy face structure, or any circumstance indicating a stone's brittle-friable or otherwise vulnerable state, which can possibly be negatively influenced by the proposed cleaning procedure, categorize and record within the vicinity detached stone fragments, and identify stones to be serviced on a copy of cemeteries map possibly coinciding with picture records. This picture recording only has value if a second copy is produced after the job

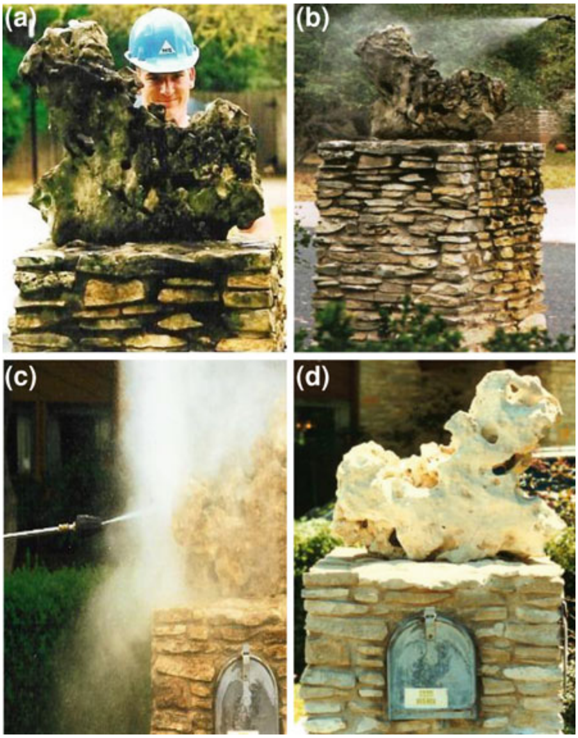

Fig. 3.174 **a**, **b**, **c**, **d** Mailbox statue

completion (job report) precisely identifying again first photo journals locations. As to safety concern or strategy, gravestones and statues are heavy and mostly not anchored therefore can topple with a minor high-pressure hose pull around their corner base. Destabilizing factors can also be excessive groundwater saturation occurring due to rain or natural high groundwater levels which is considered a warning sign. When cleaning, saturate stone surfaces and maintain a wet condition to permit contaminants to swell and soften. Water dwell time will fluctuate with stone type and weather conditions. This is especially important with marble, sandstone or slate where cleaning intervals are generally less frequent which is approximately every 8–10 years. A soft bristle brush is not advisable. Bristle will agitate interface structure with the result of having to dominate the cleaning procedure by brush stroke only.

A 45° advanced fan jet will at 1,000 psi not exert more than 20 psi surface pressure at a 2′ stand off distance. With ultra sensitive surfaces the water volume performance can be reduced to 2.5 gpm.

When mold-fungi, algae and/or lichens are visible the cemeteries management and/or memorials custodian must be contacted as to their requirements. Aged or weathered gravestones do not necessarily have to look new. The purpose of cleaning is to preserve stone longevity and the innate beauty for others to enjoy.

Fig. 3.175 City fountains

After water saturation and soaking cycle the cleaning commences from the bottom up to avoid visible streaking after the drying process is completed. If a cleaning solution is absolutely necessary apply as directed only to a prior cleaned and totally water presoaked stone, minimizing the possibility of chemical penetration past contaminated interface structure. After the chemical application by pump-up sprayer and adequate chemical dwell time the jetting again starts from bottom up. Water flushing the cleaned surfaces and neutralizing substrates interface must be performed as required by the manufacturer of detergent supplied. Only utilize products with a satisfactory and verifiable track record and only when accompanied by their MSDS identification. Liquid cleaning chemistry must be biodegradable, non-ionic, non-corrosive, non-flammable, non-abrasive, non-staining and when drying have a tolerance to high grain-hard water and emanate no odors or colors. Information and guidelines for specific locations and jurisdictions can be obtained from the international cemetery, cremation and funeral associations (ICCFA).

City fountains (Fig. 3.175) and their maintenance procedures are seldom controlled by storm water management agencies, simply because water balancing and control will require a chemical intervention probably by chlorine or an alternative such as sodium bromide (never use copper-based algaecides). This means drainage of fountain-water can never be permitted to any street or storm drain.

Water content, probably contaminated, must be discharged to the sanitary sewer system. Most localities demand water testing and require chlorine to dissipate to less than 0.1 ppb or total neutralization before this water can be recycled or reused by gradually draining it to a landscaped area. More often cleaning services are only required for seasonal or aesthetic reasons. Moreover large unplanned maintenance on or in fountains is always related to a technical maintenance question, which can be the maintaining of submerged lighting fixtures, nozzles and pump equipment, cleaning aggressive algae contamination due to faulty filtration system and metering devices, and repairing coating failure (Fig. 3.176) or removal of existing coatings to facilitate a new installation.

Fig. 3.176 Fountain structures

Most often coating failures can be documented due to poorly prepared substrate, and design circumstances relating to negative water entry through cracks or moisture vapor emissions from saturated concrete areas introduced by adjacent wall systems. Coating blisters indicate water-moisture accumulations on the negative side of the a coating system requiring total removal by preferably the UHP jetting procedure utilizing a vacuum head for the direct transfer of coating residual. The hydro-blast application is also practical, especially when a certain degree of surface roughness must be established. Under such a circumstance, the hydro-vac system is utilized to remove and separate coating residual and recycling of the blast water. Some interior concrete surfaces may also require further treatment via high-pressure water abrasive-blast techniques such as those described by the coating manufacturer or the engineering consultant whose methods are most often investigated and determined to be the prior cause of coating failure. This coating removal application requires industrial tooling, which is also utilized for applications found in theme-park facilities, aquatic marine pools and tanks. Tool requirements will vary with every application and coating-substrate encountered.

Coating removal applications in theme-parks fountains and water slides are often a seasonal prerequisite, or removing coatings in aquatic and animal habitat housing which deserves specialization can greatly be supported by offering surface cleaning applications starting with pedestrian areas, including bubble gum removal, cleaning and disinfecting of joyrides (Fig. 3.177) which is necessary after an emergency repair procedure and/or specialty work such as dredging pond bottoms supporting aquatic life, etc. by utilizing the hydro-vac system. Inquire through industry resources the "international association of amusement parks and attractions", http://www.iaapa.org.

Residential swimming pools, including Jacuzzis, will accumulate fats, bio-film resulting from free-floating micro organisms, oils, calcium-chlorine crust appearances adhering to surfaces and/or obvious waterline and runoff-splash areas. Commercial and municipal pool installations require special attention due to increased contaminating source (humans). Cleaning services will always be

necessary within this environment therefore the only question is the feasibility warranted for a pressure-washing contractor to participate in this market. Any pool service company under seasonal pressure is well advised to incorporate existing pool cleaning experience by upgrading equipment and tool capacities into the municipal pool, aquatic–marine, hotel and theme park environment, where a customers managerial obligation reflects operational maintenance cost. Professional pool operators of America provide within their association a technical information base concerning all major coatings, contamination and bio-film structures and their removal criteria. This knowledge base can further be exploited and enhanced into the prior clarified statuary–monument and fountain cleaning and coating removal application criteria, http://www.ppoa.org.

The pressure washing contractor may consider the pool cleaning application when his overall contract includes surface cleaning applications in business's parking facilities, arrival and departure areas, brick and stone work in atriums, wooden fencing and gazebos or cleaning of restaurants produce receiving and trash collection areas or restaurants ventilation equipment, etc.

For the above-mentioned cleaning applications the rotary spin-jet surface cleaning unit is perfect when operated with hot water at 200°F plus at 3,000–4,000 psi. Soaps, disinfectants, degreasers or light acids can also be introduced and are of an advantage under various circumstances. A one size fits all chemical application criterion can not be established due to the encountered job varieties. When applying chemicals a material safety data sheet (MSDS) must be present on the job site indicating chemical structure (bio-degradable). Chemicals can be applied with an up-or downstream injector or directly admixed to the float tank (disinfectants). To avoid aggressive behavior in a pressure washer system, acids are either applied manually via a pump-up unit or pulled by a low cost abrasive-blast injector affixed ahead of the gun and lance assembly. Proper acid water ratio is simply achieved by the utilization of a hose clamp restricting the acid flow approximately 4 ft beyond the acid container. The suction hose must be acid compatible and is down sized in relation to existing abrasive hose assembly. Adequate protective clothing and sometimes respirator gear are necessary. Choosing the necessary application process depends solely on area coverage requirement. In high-traffic areas and areas where traffic is difficult to control, signage procedures must be obvious and legal.

In a pool bidding process a contractor should also consider the overall pool areas that may include cleaning wooden decks, stone-work, sidewalks, etc. Wood can be restored by a high-pressure water application and supported by chemistry to visually near-new appearance. Whenever possible, expansion joint cleaning of cement floor structures and a resealing process with caulking can often be included in a bid procedure. The hydro-vac system belongs to the pool equipment palette as its application can specifically remove various contaminants in a general product transfer or a dredging function from hotel indoor–outdoor water gardens. Paint removal and concrete resurfacing procedures (Fig. 3.178) including the removal of faulty base aggregate are applications perfectly suited for aquatic–marine tanks requiring a new coating installation. Concrete liner of ¼″ to ½″ depth is easily

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Hydro-blast equipment:

Equipment:

Expendables:

Fig. 3.177 a.b cleaning and sanitizing rides

Product Encountered:			
Hazardous Material:	MSDS:		Specify:

Describe application and work procedure:
Describe safety procedure:
Itemize equipment, safety gear, expendables, etc.:

Prevent damage from temperature cycling to repaired or restored concrete structures by preparing the old or new poured concrete interface with high-pressure water:
For small areas utilize the water abrasive-blast technique at 3000 psi and 5 gpm. On a newly poured interface prepare the surface by applying 15 ° fan-jet at 2500 psi and 5 gpm.
For widespread surface areas with an old or new pour interface exploit the available Rotary Spin-Jet Equipment for surface cleaning applications (flat-work). Pressures and gpm performance according to equipment design which can start at 3000 psi and 5.5gpm.


Fig. 3.178 preparing concrete interface

removed applying ultra high-pressure creating a new surface structure, while removing the deteriorated coatings or tank liners.

Gun barrels featuring a blast screen will aid operators in visual control while adding extra protection from flying debris when a vacuum supported trigger-gun is not available. Typical hydro gun operations are without a limit to the imagination and best performed when the operator has the knowledge to select adequate

nozzles and psi–gpm ranges according to the products and substructure encountered.

GEAR - LIST AUTHORIZATION

Ornamental-statuary-monuments, city fountains, hotel-municipal, aquatic-pools-tanks

Customer & Company: Web site e-mail		Date: Address: City: State:	Job Nr: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Cemetery: Statuary: Monument: Theme-park Fountain: Aquatic-marine tank: concrete: steel: fiberglass: Swimming pool: Sewers: Pipes: Others:			Mud: Bio film: Chlorine-Calcium deposits: Bacteria contamination: Fats: specify: Others:	yes	no
UHP equipment: Pressure washer: hot-cold Hydro-blast unit: hot-cold Pipe cleaning nozzle: Vacuum truck: Hydro-vac system: Vacu-box: Pump-up spray applicator: Abrasive-blast injector: Abrasive: specify: Vacuum supported surface cleaner: Water-recycling equipment: Other:			Acid: Rust inhibitors: Caustic: Detergent: Foam nozzle: Wand extensions: Tank coating: specify: Fountain coating: specify: Plastic sheeting: (visqueen) Traffic control: specify: Rags: Other: specify:	MSDS	

Describe application and work procedure:
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.

3.18 Polishing, Etching, Metal Burr-Flush Removal, Coarse Edge-Weld Seam Polishing, Surface Modulation

Developed in the late 1950s this metal modulating application is today fully-automated, operating between 10 and 90,000 psi and does generally not belong to a service providers–contractors application standard. The process of removing protruding metal burr-flush with high-velocity water or water-jets saturated with abrasives was manually utilized in foundries producing engine blocks (Fig. 3.179) and parts (Mercedes-VW). Due to this awareness hydro-manufacturers and contractors alike tested and experimented with this jetting technology within the manufacturing environment and metal industries (foundries, sheet metal industries, construction sites, etc.). Once the desired results had been achieved the successful manual method quickly gave way to automated remote-controlled systems accommodating and rationalizing the task of high-volume production. Automated processes were first visualized and perfected for the production sequences of engine blocks, crank shafts (Fig. 3.180), pump impellers, and all products requiring (for completion) final removal of casting sands, remaining ceramics, metal burrs-flush, drill burrs and hardened dried drill oils. These automated systems are manufactured in all sizes ranging from cabinets to drive-in or through rooms, accommodating the industrial products physical size and while in operation conceal the developed noise levels, abrasive dust and water-jet emissions. Regardless of pressure-gpm requirements the exterior control panels are designed to permit access to all protruding metal remnants and possible sand filament while at all times providing a safe continuous operation. Equipment designs incorporating hydro trigger-gun and lance fixtures which are either semi-manually or hydraulically controlled while also totally containing water jet's recoil forces. Product in question is affixed to an rotating tool base which provides the necessary access to all vital problem areas. Acceptable visibility is achieved by an exchangeable center glass or rotating window system designed to absorb, reflect and flush, upon contact, mud from its viewing surfaces. Blast cabinets or designated blast areas also provide water recycling with an adequate filtration–polishing capacity, circulating water back to the suction site of a stationary hydro-pump unit.

Fig. 3.179 Cast sand removal from engine block

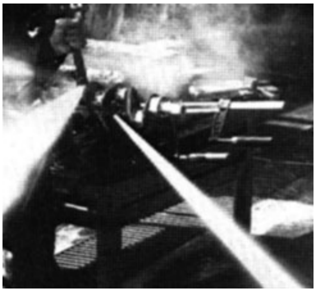

Fig. 3.180 Cast sand removal from crank shaft

Fig. 3.181 UHP abr. cutting

When manually cleaning oil–water passages filled with sand, loose or partially-adhered metal flash or burrs in engine crankcases (mechanically developed by drilling procedures) a short 1⁄8″ schedule 80 rigid lance is placed with the nozzle directly on the opening and pointing in line to the passage at operating pressures up to 14,000 psi at 16 gpm. The developed and channeled water velocity removes all baked sands and metal burr-flash. The minor metal flash remaining are so strong in structure that further breakaway during an engines operation are impossible. Cleaning time per passage will not exceed 15 s. Most drilled passages within an engine crankshaft will not permit internal nozzle manipulation to eliminate excessive water-jet ricochet; therefore, manufacturers affix jetting nozzles directly to the lance body enhancing the possible access to the drilled orifice (welded or threaded form). In any case, the crankshaft's drilled or cast oil passages are short in design therefore cleaning times will not exceed 6 s per passage. Naturally, time parameters will change with size of engine shaft encountered. It must be guaranteed that the utilized vise-fixture can adequately hold and absorb the hydro-jet's transferred kinetic energy. The effectiveness of any abrasive or, for this matter, blast medium, to enhance remove or otherwise manipulate surface conditions and appearance also depends on the following technical variables: the mix ratio of water and honing-abrasive medium type, hardness, grain shape, sieve-mesh size, injector-nozzle distances from the surface, surface type and structure, and the injector's ability to produce an adequate blast pattern superior to most common water-abrasive blast injectors and their available support equipment. A contractor wishing to utilize abrasive application technology can verify in chapter "core applications" 23 industrial–commercial-marine applications (Fig. 3.181).

GEAR - LIST AUTHORIZATION

Polishing, etching, burr-metal flash removal, weld seam polishing, surface modulation

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e-mail:</td><td colspan="3">Date: Job Nr.:
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City: P.O. Box:
State: Zip Code:</td></tr>
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e-mail:</td><td colspan="2">Safety:

Tel:
e-mail:</td></tr>
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Construction site:
Casting:
Engine blocks:
Crank shafts:</td><td></td><td></td><td>Pump impellers:
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Glass:
Aluminum:
Granite:
Other:</td><td></td><td></td></tr>
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Metal burr-flush:</td><td></td><td></td><td>Drill burrs:
Casting sand removal:
Sand filling:
Other:</td><td></td><td></td></tr>
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Metal beads:
Plastic beads:
Nut-shells:
Cement dust:
Fly-ash:</td><td>Profile:</td><td>mil.:</td><td>Sieve-mesh size:

Aluminum oxide:
Silica:
Garnet:
Sand
Soluble abrasives:
Sawdust:
Grain-shape: Hardness:</td><td>Profile:

MOHS:</td><td>mil.:</td></tr>
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<tr><td>Equipment:
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Pressure washer:
Abrasive injector:
Abrasive cutting heads:</td><td></td><td></td><td>Bulk container
Vacu-jet recovery system: “Wet”
Vacu-jet recovery system: “Dry”

Other:</td><td></td><td></td></tr>
<tr><td colspan="6">Describe application and work procedure:</td></tr>
<tr><td colspan="6">Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.</td></tr>
</table>

3.19 Sewers, Laterals, Culverts, Sumps, Industrial Pipe Cleaning, Pipeline Cleaning and Cutting Applications

Conceived and developed by Wolfgang Maasberg Sr. in 1956 and finally patented in 1958 Germany, the self-propelling (Figs. 3.182, 3.183) sewer–pipe high-pressure hose or rigid lance mounted nozzle configurations (USA 1960) where the

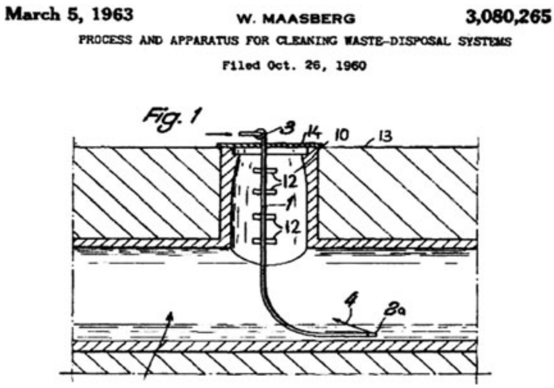


Fig. 3.182 The sewer and pipe cleaning invention 1957

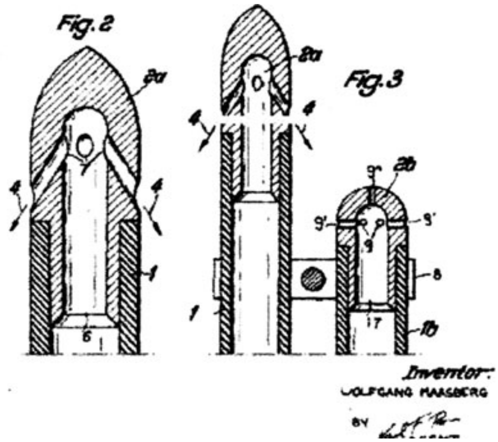


Fig. 3.183 Nozzle invention draft 1960 USA

result of his industrial pipe cleaning method (Fig. 3.184) utilized in dairies and chemical production facilities. The inspiration to first develop and manufacture truck chassis mounted industrial pipe–sewer jetting vehicles followed quite immediately. At the same time manually performing the strenuous pipe sewer cleaning method also produced the motivation to manufacture hydraulically operated hose reels, which were immediately successful. Combining the industrial continues vacuum performance of 4,000 Cfm and 29″ Hg, generated by injector ring pumps then in operation for dredging or product transfer applications (hydro-vac system) and combining this equipment and tooling to truck chassis where worldwide the first commercially available so-called combination units delivered in 1960 to municipalities. From the beginning PTO drives were applied to transfer power to 75 and 150 hp pumps. As to the question; did the sewer cleaning application come first or industrial pipe cleaning?, it was industrial pipe cleaning for the removal of hardened industrial products requiring water pressures and gpm performances not jet available in a compact configuration suitable for installation

Fig. 3.184 Engineered to avoid jet-energy destruction

on a mobile truck or trailer mounted unit. This also channeled future European pump designs to achieve higher performance levels in a much smaller configuration.

As within the industrial environment, identifying the encountered pipe–sewer systems age and operational definition which might be or is of a lateral type connecting a private residence or rural business to its sanitary sewer district can sometimes present to the inexperienced an array of bewildering consequences. Due to unforeseen pipe combinations, which can be starting with; cast to ductile iron into an Orangeburg lateral pipe, in areas fixed with vitrified clay–ceramic–crock pipe connected to a new concrete pipe which was installed last year replacing parts of the combination sewer. This type of scenario requires attention as to structural integrity; application technology applied preventing possible damage, therefore acquiring visual proof of system's condition before a correct tool selection can be introduced (Video inspection).

A highway drainage system can also be connected to a storm water detention facility of various design controlling storm water runoff and capacity, however they almost always suffer from mud-silt accumulations which are in comparison the simplest application of jetting and/or refuse removal nature. Storm water systems, which carry typical runoff from any rain event in a watershed, can sometimes be incorporated into a storm water detention facility. Cleaning sanitary sewer systems from generator to a wastewater treatment facility refers to residential, commercial and industrial discharge. This type of liquid discharge carries human waste, chemicals, commercial byproducts, grease, pollutants and various toxins. Some of these discharge events are controlled and licensed such as for instance the discharge of Laundromats, food processing, or various identified manufacturing processes.

It is this type of discharge, which can be fatal when neglecting standard safety procedures and under-estimating the possible destructive nature created by sewage accumulations within its confined environment. Flagrantly tossing cigarette butts down a culvert shaft is an unacceptable behavior pattern almost always displayed by a novice claiming professionalism. Due to the generally unknown raw sewage composition and possible development of gaseous atmospheres, safety minded equipment technicians and labor force will adhere to a proven operational sequence which is at all times maintained. It is necessary to identify and confirm the materials and the general environment encountered throughout the sewer pipe system, including the verification of the system's structural integrity. EPA

Fig. 3.185 Combination sewer jetting-vacuum truck since 1963

regulations on solid and hazardous waste removal as defined in 40 CFR 261 must be understood by all involved. The labor force may enter a sewer system only after safe conditions are established and all safety-confined space entry procedures are considered, including the supply of adequate ventilation, breathing apparatus-egress system, confined space entry permits, etc.

Operators with pipe–sewer cleaning experience (Fig. 3.185) will differ in their operational judgment and therefore professional quality. Technical experiences combined with a healthy vivid imagination, or better yet, gut instinct especially in industrial environments to identify downstream–upstream pipe access, line flanges-lids, bends, underground pipe damage and retaining an imaginative typing capability of possible obstructions encountered by the sewer cleaning head will separate the men from the boys. It is very important for operators to monitor the amount and type of debris passing by the service manhole or being removed from a pipe–sewer line. Excessive backfill material and or pipe fragments can indicate a pipe failure requiring job shutdown to facilitate a closed circuit television inspection. This experience to effectively categorize waste-product is nowadays greatly supported by closed-circuit television inspection identifying current sewer conditions for possible problems stemming from pipe deterioration, collapse, defective gaskets and root growth (infiltration), pipe joint damage and/or the nature of general blockages. This camera work can only support a pipe–sewer inspection when pipe systems are either clean or partially cleaned to identify interior obstruction or blockage. This means any sewer system needs a cleaning schedule to facilitate operational security and unhindered CCTV inspection access. In the real world, a contractor is called out when a pipe sewer system fails due to blockage. Regular cleaning intervals are of utmost importance and considered a maintenance necessity in areas where sewer systems are subject to increased calcium-carbonate sedimentation, as generated by liquids from industrial laundries or manufacturing facilities where organic–inorganic materials are delivered in volume and deposited throughout a system accumulating scale and minerals on pipe walls. The reduction of effective flow by increasing interior surface roughness, and the course of developing restrictions can also be a result of a so-called tuberculation, where products react to pipe material in itself often a criterion in industrial environments. These are pipe cleaning circumstances where cleaning by

mechanical methods utilizing auger or metal cable-rod equipment with lateral cutters, flat or concave blade, milling plates, etc. or a variety of milling heads which are prone to damaging pipe systems were a common practice. In this application the hydro-method differentiates in that mechanical tools and metal snakes lack the capability to conform or adjust to changing sewer pipe profiles and will create a real problem when confronted with a protruding tap-stub extending into a sewer line. This type of equipment should never be employed if a blueprint identifying existing lateral or directional bore connections is not obtainable. Metal rods or snakes also do not ventilate a sewer system during the cleaning process and furthermore, will not remove heavy materials from the lower sewer invert.

Contractors in their desire to land a job opportunity often forgo the need to acquire from the prospective customer information regarding a systems repair history, adequately identifying type of pipe material and/or design variation present on site, possible condition of the pipeline and its access locations and detailed information as to past cleaning history and its possible problematic. This information base should be the criteria, which permits the selection of adequate tooling. The type of sewer systems can be referred to as combination found mostly in rural areas, retention and or highway drains, and detention systems for storm water and the cleaning of storm water drains, sanitary sewer systems and their lateral connections.

Laterals connecting to sanitary sewer pipe can be Orangeburg to PVC color-coded pipe, where green identifies sanitary sewer service, leading from a combination of cast or ductile iron pipe to vitrified clay pipe or any combination thereof, to a sanitary sewer main constructed of steel, brick and/or reinforced concrete pipe. In the last 40 years Truss pipes® manufactured by Contech are also resistant to chemicals found in sanitary sewer systems and offer a glossy smooth interior with water tight joints, preventing ground water infiltration and root growth starting in diameter from 8″, 10″, 12″ and 15″ ∅ can show in certain areas predominance (new developments).

Water retention systems constructed of corrugated coated steel, corrugated smooth wall, high density polyethylene pipe (HDPE) and storm drain systems manufactured from brick, steel and concrete (reinforced) starting at 18″ ∅ pipe diameter to large drainage box culverts are structural generalizations never to be trusted and must be verified before a tooling selection and cleaning-jetting procedure commences.

Sewer cleaning techniques (Fig. 3.186) begin and end with the basic understanding that all materials and obstructions must be removed from their inverted surfaces. It is therefore imperative to realize that cleaning procedures started at the elevated side of any given pipe system defeat or severely hamper the created water flushing velocity carrying the generated sewage downstream.

Whenever possible, qualified operators simply begin their cleaning procedure downstream from the obstruction within the sewage pipe system, automatically guiding him to the nearest manhole shaft, culvert or service lid. At this point, and in increments the hose-nozzle assembly is sent upstream in the direction of the existing obstruction pulling back settled debris.

Fig. 3.186 Low profile cleaning

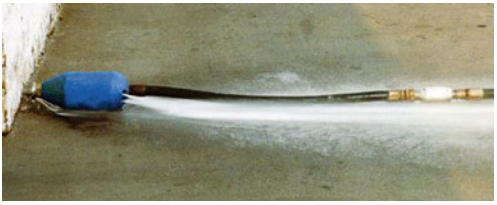


Fig. 3.187 Skipjack directing jet energy to pipes lower inward

The selection of nozzle type will dictate jetting performances, and their intent. A deteriorated and fragile but open unclogged sewer–pipe can gently be cleaned by a stepped and repetitive jetting procedure in the bottom quarter (Fig. 3.187) of pipe radius, utilizing nozzle carriers with jet configuration in a plane pointing and accelerating waste accumulations by water velocity creating no potential jet impact to interior deteriorated pipe walls which also permits an extended jetting hold time mounting water velocity towards waste accumulations (Figs. 3.188, 3.189). The nozzle design must make sure that hose weight and nozzle thrust can not create nozzle jet angulations subjecting pipe wall to a direct jet impact.

When cleaning large sewers (above 2′ ½′ ∅) a so-called "skip-jack" nozzle, designed to direct nozzles available water velocity to the areas most needed (lower sewer invert), proves useful and renders cylindrical nozzle carriers quite insufficient. Cylindrical nozzle carriers can lose in open sewers, up to 70% of the developed jet velocity toward the upper radius of mostly clean sewer inward.

A blockage removal in sewers is to propel a nozzle upstream punching through a waste accumulation facilitated by one forward nozzle making way or climbing over the debris field. The rearward facing jets are applied in a repetitive hose rewind method to aggressively breakup in increments and washing the material towards downstream manhole. Once the bulk of blockage has been liquefied a repeated steady sewer-hose rewind of never more then 1 fps is maintained to ensure effective flush-out of materials from the lower sewer circumference.

When having to flush from an upstream manhole to remove a blockage extreme care must be taken when placing a nozzle-hose assembly into an upstream sewer access which is most likely obstructed and visually hidden by murky water.

Fig. 3.188 Calcium deposit

Fig. 3.189 Calcium deposit removed

Nevertheless, all possible safety precautions must be undertaken when deciding on a nozzle placement deep enough into a sewer access, circumventing all accidental back-slippage or failure of containment within the sewer–pipe before hose pressurization occurs.

If necessary, the downstream pipe–sewer system is closed off utilizing expandable rubber bladders or netting to prevent further downstream debris accumulation. Before pulling the sewage or debris toward the entered service side the operator should utilize a hydro-vac system to remove accumulated debris, facilitating flow and protecting against further downstream contamination (sewer plug, bladder, and netting).

Working from a downstream location such as from a manhole the placement and release of a sewer cleaning nozzle must be exercised with care. If a pipe–sewer system does not present a blockage utilize a nozzle carrier with rearward facing jets. Insert the nozzle carrier to a minimum of 3′ before engaging the jetting pump.

A noticeable abrupt color change of passing sewage water must always prompt an immediate research criteria and discontinuation of the jetting procedure. The sewer cleaning nozzle has most likely penetrated into an area where pipe damage is present and will move with its jetting velocity soil and pipe fragments, visually identifiable toward or by passing the manhole. Experienced operators will mark the high-pressure hose at its entrance to permit the exact measurement to the probable pipe damage area above the ground after hose retraction and footage

Fig. 3.190 Jet energized root cutter

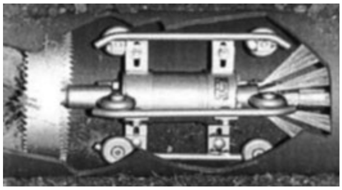


Fig. 3.191 In operation root cutter

Fig. 3.192 Frontal view root cutter

between the mark and sewer nozzle becomes accountable pointing directly to the area where possibly a trench degradation is visually identifiable. It may not necessarily be a collapsed pipe section but may be a joint failure with loss of gasket beginning to separate from its adjoining pipe. This can cause infiltration of backfill and soil. Also joint separation often reveals vegetative growth, which can be root strands, entering tight gap and cracks mostly growing in the top half of a pipe's circumference. Hair like roots can be removed with a jetting procedure but fully developed tree roots require the application of a self-propelled root cutter (Figs. 3.190, 3.191, 3.192), energized via high-pressure water (combination of sewer nozzle and circular spring saw), operating between 35 and 60 gpm at no more than 4,000 psi. This equipment performs effectively in pipes ranging from 6″ to 24″ ∅. They will be tricky to operate and require some working experience not obtainable through an owner's manual (read it anyway).

Operators must also realize that cutting equipment only provides a temporary solution to the problem. Roots, if not chemically treated by destroying their plant tissue will come back in a fury. Contractors rely on these units when their available hydro-power and nozzle selection proves ineffective especially in areas where waste products or hardened materials intermix with construction debris and the application of percussion milling cutters may be employed.

Storm surges can wreak havoc in sewage treatment facilities when a storm event explosively discharges waste-product combined with rushing high-volume water. An unforeseen or hidden blockage giving way by developing pressure is

Fig. 3.193 Skipjack nozzle

most likely also the area where odor developments and infectious blood pathogens including bacterial breeding possibilities do exist. To avoid such a circumstance sewer districts tend to utilize a flushing procedure, introducing a heavy flow of water into the upstream man hole of festering waste accumulations flushing floatable and grit waste down stream. This is the most effective when combined with a downstream jetting procedure, moving materials toward the water treatment facility. Typically the larger the pipe diameter, the higher the required equipment flow rate and water volume introduced to sewer system. The industrial service provider is most likely in possession of various industrial pipe and sewer cleaning equipment which is designed to operate within a much higher performance criteria to clean or remove product from within high density polyethylene, concrete and clay pipe systems to cast-iron and steel–stainless steel pipe installations (Figs. 3.188, 3.189). Therefore it is quite simple to add the income potential of the commercial pipe–sewer cleaning environment with a few equipment changes and adjustments enhancing existing hydro-blast unit's field of operation. To fully compete within this commercial business identity and avoiding the cost of purchasing sewer–pipe jetting equipment, including vacuum truck combinations a simple equipment psi–gpm manipulation or conversion is performed. Nowadays most hydro-blast pumps feature a plunger-piston exchange capability in order to gain water volume in exchange for, or sacrifice psi performance.

This change over will result in a combined higher nozzle recoil force (pulling force) and jet impact velocity (mass). This technical requirement for trailer or truck mounted compact hydro-blast equipment gaining a higher water volume configuration is most likely necessary when sewer–pipes exceed 30″ in ∅ or a excessive sewer incline (grade) must be overcome. Depending on application and pipe material encountered hydro-blast equipments psi capacities may also effectively compensate for the hydro-blast unit's lack of water volume (Fig. 3.193).

To avoid pipe damage, pipe diameter and distance to be cleaned, existing dry sewage volume and structure must by understood to correctly choose a tool-nozzle selection accommodating the application at hand utilizing 5,000 psi plus at 22 gpm plus which is most always sufficient when cleaning and flushing 18″ ∅ sewer pipes. However, these performances will prove totally inefficient when challenging 4′ ∅ sewers. Regardless of psi applied, a nozzles dwell time most not exceed 30 s.

Selecting a nozzle's jetting angle to protect sewer pipe interior surfaces, influencing propulsion thrust and cleaning efficiency for a sewer-hose assembly is

Fig. 3.194 Centralizer 3D nozzle

Fig. 3.195 Nozzle centralizer

Fig. 3.196 23000 psi 3D nozzle and centralizer

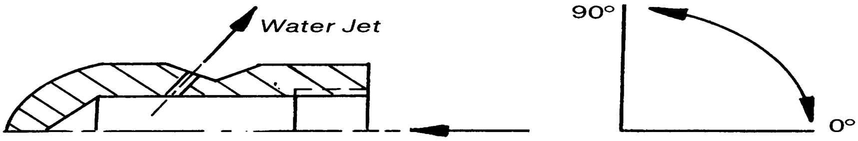


Fig. 3.197 The closer the jet angle to 90°, lesser hose propulsion and flushing capacity but high impact to adhering contaminants

today relatively of predictable nature due to municipalities uniform sewer pipe system designs and the general nature of sewage deposits. Be wary of enthusiastic nozzle salesmen (Figs. 3.194, 3.195, 3.196, 3.197).

Important variables are: the pipe ∅ to be cleaned, where large ∅ requiring a wider jet pattern, and higher water volume. A fragile or relative vulnerable pipe condition demands that the water velocity to remove debris be directed to the lower circumference producing a shallow jet pattern, preventing a higher jet impact upon the pipe wall.

When there are extensive debris loads deposited on the bottom half of the circumference of a pipe system, jetting power must be directed onto the side walls and pipe bottom inward. Also a possible sewer slope-incline-grade must by correctly calculated and included when choosing a nozzle's thrust capability adding to a nozzle selection criterion.

A typical jet angle of 30° to 35° provides an optimal cleaning capacity with correlating thrust provided by water volume, a jet angle of 15° to 20° provides satisfactory cleaning capacity with higher thrust at the same water volume, and enhanced flushing characteristics, and 10° nozzle provides very good thrust at same water volume but lower cleaning effectiveness up on the pipe's side wall with high water flushing and atmosphere replacement characteristics when upstream sewer access is opened (venturi effect). On this note to avoid the possibility of a nozzle turnaround and risking injury; it is an excellent practice to employ and install between sewer cleaning nozzles and hose armature a seamless schedule 80 stainless pipe extension 1.5 times the internal ∅ of the sewer pipe being cleaned. In industrial applications this practice is seldom performed due to tight pipe radiuses encountered within product transfer facilities. Operators must strive to understand the encountered sewer–pipe system before the final tool selection is made. Diameters and profiles of sewer pipe systems, distances between manhole shafts, surface openings and their accessibility, debris classification in terms of viscosity, scale consistency (tensile strength) and adhesion, specific weight, and the overall product volume throughout are the common factors when deciding on a nozzle specification.

To reiterate once again, the actual sewer pipe cleaning procedures begin by placing the sewer cleaning nozzle deep into the pipe's orifice so that accidental dislocation of the nozzle into the service area or man-hole cavity is not possible. If done incorrectly a grave threat to the workers exists when the high-pressure hose is energized and the nozzle becomes mobile. The sewer cleaning nozzle and hose assembly is advanced by 15′–30′ increments and is always returned under pressure within 5′ ft of pipe access utilizing the hydraulic reel. In its path, all loosened debris is flushed into the open cavity reducing pipe's surface friction and enhancing velocity factors as the nozzle-hose assembly returns to remove waste deposits within the next 15′–30′ of sewer. Hundreds of feet can be cleaned by this repetitious, step-by-step debris pulling method. To avoid a nozzle turnaround, especially possible within in larger pipe radiuses, or a disappearance of the nozzle into a smaller lateral pipe and/or unknown fractures within a sewer system the hydraulic reel operator must never allow hose slack during nozzle advancement only possible when premature hose release is introduced (hose feed outperforms nozzles advancement).

To eliminate hose damage while the hydraulic hose reel is operated (retrieving high-pressure hose under jetting mode) a roller assembly is installed to the

manhole-sewer edge or a tiger-tail hose guide is applied. The unit's hose reel is situated above the manhole shaft in such a way that damage to the high-pressure hose on the manhole's rim will not occur. The durability of hydro-blast hose assemblies outperforms nylon sewer cleaning hose. Specific nylon sewer cleaning hose effectiveness lies mainly in their light weight, high water volume delivery and low friction factors at given low input performances of 1,500–4,000 psi to 60 gpm. Industrial high-pressure hose assemblies designed with high-pressure water cleaning in mind are generally suited to accommodate the necessary volume and psi performance criteria.

Due to hydro-blast hose weight and stiffness most hydro-blast units utilize a hose reel affixed to the rear frame eliminating the strenuous hose retrieval procedure often applied in the industrial application criteria. For sewer cleaning applications, the high-pressure hose assembly must be able to be pulled under pressure which is an absolute requirement for a successful cleaning procedure.

To remove debris from manholes or sink basins the wet hydro-vac method energizing a mobile industrial vacuum box has its advantages when compared to a large cumbersome vacu-truck, particularly when work is performed in confined areas (refineries) where pipe sewer systems may also hold flammable liquids or gaseous vapors. The jetting water is supplied to the hydro-unit suction tank or tank truck in tandem and/or directly drawn from a fire hydrant. Operating a fire hydrant's valves to meter a low water amount may result in severe hydrant valve surface damage. A 2½″ or 1½″ butterfly valve with a hydrant swivel is suitable to independently meter water. To avoid unnecessary system contamination the hydrant's stand pipe is always purged of debris before the fire-hose assembly is connected to an open tank assembly avoiding water contamination by back flush to hydrant.

Pipe and sewer cleaning within the industrial environment can challenge a novice's nozzle selection criterion. Nozzle psi–gpm performance aspects change according to product manufactured, fouling temperatures most often responsible for varying adhesion, viscosity, and/or tensile strength of product to be removed, sewer–pipe design and access including varying radiuses drastically vary with products manufactured and plant process regulations, which include an ever-changing safety criterion.

When industrial oil or grease traps, septic tanks, chemical and oil skimming vessels, etc., in factories, chemical plants, shops, correctional facilities and so on become part of the sewer–pipe cleaning application the business identity changes abruptly to a waste haulers criteria and its job description due to a number of added constraints which must be considered: A "generator" is a descriptive view of a customer who produces hazardous or non-hazardous products and offers removal of the product to a secondary location. In our case this represents a licensed disposal site. The customer (generator) is therefore interested in determining cost factors of product removal starting with correct load estimates and precise volume recording per load transported. Generally the generator feels most comfortable with the estimation of vacu-truck loads necessary to remove his material rather than determining product volume by mathematical methods. Preferably vacuum

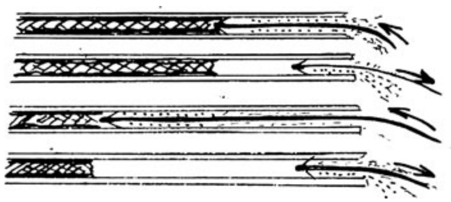


Fig. 3.198 Tube–pipe cleaning sequence

box equipment provides a calibration method to inform the observer of contained and accumulated product volume. Hydro-guns with lance extensions and a variety of accessories play a vital part in the agitation process of caked products, thus reducing friction factors throughout the vacuum hose assembly while loading. This equipment also supports the final job area cleanup.

Before transportation of any product or waste, the generator must guarantee and certify that no hazardous materials are removed from his property or identify, and classify hazardous-waste for a correct disposal and transportation method. This certification is added to the liquid waste transportation trip ticket, also indicating the necessary vehicle permit number, business name, gallons removed, waste hauler registration number, certified product identification and disposal information indicating the disposal site's business name, address, state waste hauler permit, etc. These transportation tickets will vary from state to state by law and implication.

Operational qualifications are tested in industrial pipe cleaning practices where the variety of products, their adhesion factors, viscosity, tensile strength and hazardous classification (safety procedure) are never the same; this includes pipe interior ∅, and surface condition, location and design, pipes may vary from ¼″ to 12′ ∅ plus and therefore demand a wide variety of hydro-tools to successfully fulfill the application criterion. Pressures start at 3,000–45,000 psi, utilizing volumes from 2.5 to 80 gpm. Because of service location and general plant circumstance the manual pipe cleaning practice is more often considered and prevails by applying foot valves or trigger-guns with ¼″ flex lances to ½″–¾″ ∅ high-pressure hose assemblies. Nozzles are selected depending upon the individual application. One must consider all flow restrictions and water mass movement through hoses and tools. Semi-or automated equipment is also available, but can be impractical, not cost effective and sometimes is too slow.

As mechanical or hydraulically controlled sewer cleaning applications, the manual cleaning of tubes (Fig. 3.198), pipes and sewers will require cleaning techniques, psi–gpm performances and equipment choices categorized into five prevailing application techniques differing in tooling and application process quite drastically to automated processes.

When the degree of pipe soiling or the nature of product is inconsistent or its structure and physical tendency is an unknown, for reasons of safety the manual cleaning of pipes and tubes must be performed in a progressive method.

Normal pipe or tube cleaning endeavors applying ½″ hose or flex-lance equipment will exploit nozzles with a 45° jetting angle, providing a good trust to

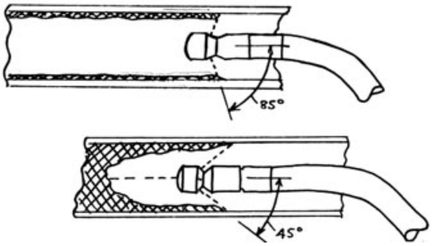


Fig. 3.199 Jet angle

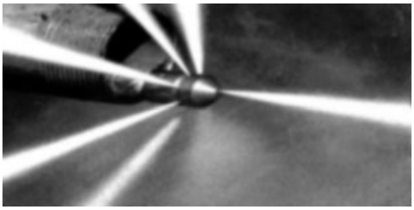


Fig. 3.200 Poor jet formation, jet energy destruction

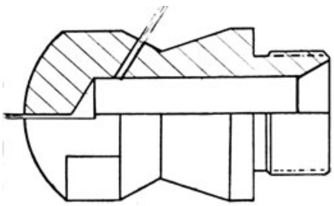


Fig. 3.201 Pipe nozzle

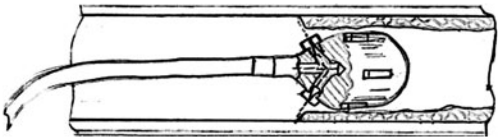


Fig. 3.202 High impact nozzle carrier

propel the nozzle-hose assembly (Figs. 3.199, 3.200, 3.201) down line (soft material).

Where the deposits are thin and hard, a jet angle choice can be 85° applying a more direct impact to soiled pipe wall but delivering enough thrust to pull hose assembly throughout the equipment serviced. Where the pipe is larger in ∅ and the deposits are also hard and difficult a nozzle carrier with 45°, 60° or 80° water jet angle and exchangeable (Figs. 3.202, 3.204) hard-hitting nozzle design (Bernoulli), permitting gpm–psi variances as application requires is utilized. This permits raising the nozzle cleaning efficiency up to 70% when compared to mechanically drilled orifices (Figs. 3.203).

When a pipe cleaning nozzle offers a foreword jet, which is only utilized when cleaning U tube condensers or pipes in a situation where blockage of a pipe is a known, a rigid-lance should never be forced nor should a nozzle-hose assembly be

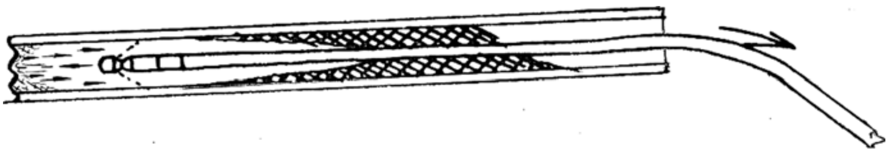


Fig. 3.203 Hydraulic force development

Fig. 3.204 Carrier interior view

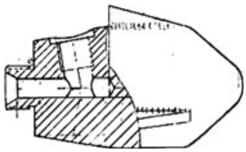


Fig. 3.205 **a** UHP hose interior ∅, before armature restriction ∅, **b** various high-pressure hose models

allowed to enter at its produced or available velocity. Pressures may develop explosively, creating a hydraulic reaction force with the possibility of blowback and again perhaps grave injury to operators.

The diameter or length of ¼″, ½″ or ¾″ high pressure hose assembly does not matter; the steel-braiding (Fig. 3.205a, b) under pressure will transmit the slightest movement by a hose-loop. When in a progressive cleaning face (Fig. 3.206) and with a little training a 30° to 40° lube turn will provide nozzle-jet coverage down through all surfaces subjected to jetting procedures.

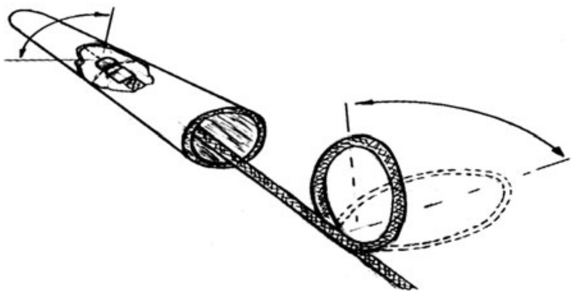


Fig. 3.206 Progressive cleaning rotation

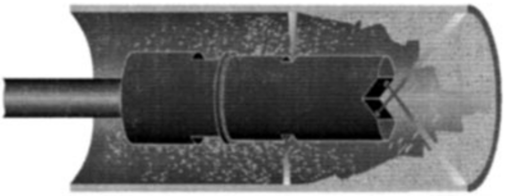


Fig. 3.207 **a**, **b**, **c** 1981 whirl-jet nozzle, first patent draft hard-brittle scale removal, hydro-vac and drill applications

Fig. 3.208 Various whirl-jet nozzle designs and ∅

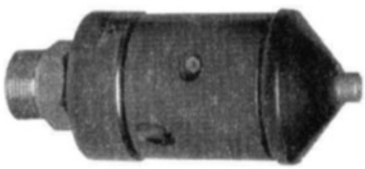


Fig. 3.209 Tube-wall cleaning nozzle

Where products are very hard or stubborn and automated equipment cannot be applied, whirl jets (Figs. 3.207, 3.208, 3.209) perform a milling process upon hardened-brittle material encountered and has literally eliminated most predominant applications where the forward facing jet designs, mounted on a rigid-lance once ruled (tremendous physical effort). There always will be specialized applications where these nozzles are a must but are most likely supported or utilized by an automated static or rotating mechanized apparatus (Figs. 3.210, 3.211).

Fig. 3.210 Rotating, forward cutting mechanized milling nozzle

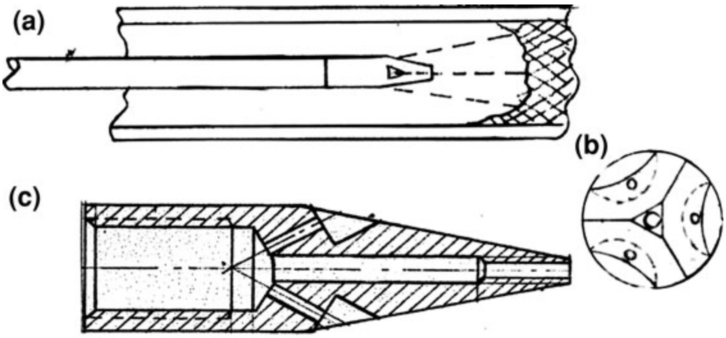


Fig. 3.211 **a** Lance-nozzle fixture, **b** nozzle top view, **c** nozzle cross section

Pipelines of various size and purpose may require internal cleaning, hydrostatic test-weld testing, and often due to corrosion problematic an exterior coating removal and profiling procedure to facilitate a new installation. Today's hydro-vac-UHP trigger-gun assemblies applying only water or a variety of abrasives are well suited for this application, especially when required in remote locations where water intrusion to surrounding soil or area cannot be permitted. The cleaning of large pipe ∅ is a straightforward proposition requiring minimum 150 hp pump drive input, large cylindrical nozzle carriers at times utilizing a nozzle centralizer. Cleaning may also be a precursor to hydrostatic test procedures.

Cutting pipelines in volatile industrial areas is an expertise most often supported by the equipment manufacturer, as it is mostly also performed by service providers specialized in the oil refining industry. To be on site accompanied by a renowned cleaning–maintenance company within an emergency scenario is naturally of an advantage (Fig. 3.212).

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:	Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:

Purchasing: Tel: e-mail	Engineering: Tel: e-mail	Maintenance: Tel: e-mail	Safety: Tel: e-mail

Job Description:

Job Location: Job Site Risk Assessment: Specify: ©

Job Review Performed by:

Pipeline cleaning: cleaning of oil and gas pipelines,
Pigging products and Services Association,
http://www.ppsa-online.com

North American Association of Pipeline Inspectors,
http://www.NAAPI.com

National Association of Sewer Service companies,
NASSCO, http://www.nassco.org

The cleaning of sanitary sewer line,
http://www.lrwu.com

Hydro-blast equipment:

Equipment:

Fig.3.212 various pipe-sewer nozzle carriers

Product encountered:

Hazardous material: MSDS: Specify:

Describe application and work procedure:

Describe safety procedure:

Itemize equipment, safety gear, expendables, etc.:

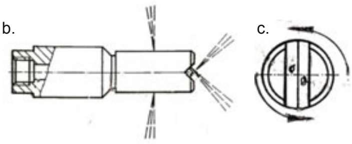


Fig. 3.207 b. c. 1981 whirl-jet nozzle, first patent draft
hard-brittle scale removal, Hydro-vac and drill applications

GEAR - LIST AUTHORIZATION

Sewers, culverts, sumps, laterals, industrial pipe cleaning, pipeline cleaning and cutting

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			
Chemical pant: Machine shops: Factories: Commercial buildings-area:		Residential buildings-area: Theme park: Industrial laundry: Other:	
Area: Production pipe: Culverts: Laterals: Sink basin: Manhole:		Grease traps: Septic tank: Oil skimming vessel: Storm drain: Other:	
Pipe size: ∅ Profile:	Length:	Manhole distance: Overall feet:	Incline-grade°:
Hazardous product: General sewage: Raw sewage:		Chemical product: *specify* Production related product: *specify:* Other:	
Root growth: Structural damage:		Nozzle: specify: Cracks: Defective gaskets: Other:	gpm-psi
Equipment: Hydro-blast unit: Plunger piston changer: *gpm-psi* Skip jack nozzle: Sewer cleaning nozzle: *gpm-psi* Self-propelled root cutter: Hydraulic hose reel: Wet-dry hydro-vac unit: Vacu-box: Vacu truck:		Sewer pipe inspector: Remote control camera: CCTV: Electronic pipe locator: Air compressor: Air blower accessories: Rubber bladder: *specify* ∅ HP hose roller-guide: Tiger-tail: Traffic barricades: Other:	
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.			

3.20 Steam–Vapor–Gas Flue Stacks, Industrial Elevator Shafts, Laundry–Garbage Chute Cleaning and Sanitizing

Flue gases are produced when coal, oil, natural gas, wood or any other fuel is combusted in an industrial furnace. This includes power plants steam generating boilers, air pollution control systems (FGD) flu-gas desulphurization equipment

Fig. 3.213 Stack and precipitator

Fig. 3.214 Stack, smelter

Fig. 3.215 Steam generator cooling tower

and its stack, turbine silencers-stacks, and any other large combustion device including flare exhaust units protecting plant hardware. Periodically all are in need of cleaning services deserving equipment-tool specialization and labor force education. Service frequency depends on time and stacks vapor–gas flow rate ft^3/s or m^3/s volume processed and interiors general corrosive conditions. Stacks are large vertical circular concrete, brick or steel pipe structures (or combination of all) with access from bottom within and/or exterior by ladder or helicopter (Figs. 3.213, 3.214, 3.215). The configuration and bid information provides specifications on stacks external–internal shell and inner external–internal flue structure and dos not necessarily provide information on variations of a stacks cross-section ∅. Stack height can be from a modest 60′ to over 1400′ plus yes, feet, therefore when extreme heights are encountered (200′) hose runs must be calculated and weight accumulations distributed. Stack-flue plate, flue inlet, false

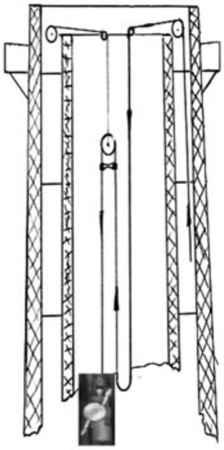
Fig. 3.216 **a**, **b** 2D nozzle, 14000 psi

Fig. 3.217 2D nozzle carrier extension

bottom and drains must be identified as to their condition, or as inspection guidelines will classify service requirement. Roof and top cone conditions, expansion joints and seals, lateral supports, or ladders, platform, grounding cable, aircraft and electrical lighting are all part of a stacks inspection checklist and record which service providers must obtain to inform him as to the overall condition before a units assessment can commence (Fig. 3.216).

A stack cleaning procedure can also be considered a pipe-combination-tank cleaning application. A tank-cleaning nozzle, possibly designed to incorporate lance extensions (Fig. 3.217) which reduces the nozzle's standoff distances to stack's internal surfaces resolves this cleaning necessity quickly. Lowering in increments the rotating nozzle from the top configuration of stacks center hose-cable guide permits a streak-less surface cleaning and appearance achievable only with a 3D tankcleaning nozzle producing time effective cleaning solutions otherwise not possible. By calculating excessive distances and heights which is a predominant application criterion common to these industrial units, a contractor may find that this application demands more rigging time than the cleaning procedure itself. A ¾″ to 1¼″ high-pressure supply hose is sometimes necessary to prevent excessive friction losses and pressure drops requiring added hp availability. When physical circumstances demand a top entrance, the 1¼″ high-pressure hose must be strung and affixed to the tower ending with ample slack to accommodate the length of flue from the platform space with its cable-reel unit. A ½″ to ¾″ high-pressure hose of total stack length is then affixed and receives the tank-cleaning nozzle on its end. If not already situated, a center-mounted roller bearing assembly retaining and a profile large enough to bed the ¾″ high-pressure

Fig. 3.218 Stack rigging



hose circumference and its fittings must be established. A ¼″ steel cable is affixed to the center of the stack's circumference. An automated cable reel assembly also often permanently installed to the platform is utilized to lower the tank-cleaning nozzle down to the bottom of the unit (Fig. 3.218).

Smooth surface variety hose clamps are sufficient to affix the high-pressure hose to the ¼″ steel cable as the nozzle is lowered into the stack, distributing accumulative hose weight effectively. When retracting the nozzle hose assembly clamps are removed before reaching the cable drum in rotation.

A bottom entrance in larger units to the inner flue may well be possible to permit a significant shorter high-pressure hose run and an altogether simpler application practice. The available tank-cleaning nozzle must feature a utility hook or eye with a sturdy, preferably watertight load-bearing fixture to permit the accumulative high-pressure hose weights to be exerted upon the tank-cleaning nozzle. If there is an excessive scale buildup allowing the possibility of product collapse into the stack's bottom, the cleaning procedures are best started on top of the unit to prevent nozzle damage by falling debris. Furthermore, the operator ensures the centering of the hose in the bottom of the unit to reduce possible loads to the high-pressure hose, nozzle and cable reel assembly by falling debris. A tank-cleaning nozzle functioning only in one circular plane will cut smaller product pieces when slowly lowered therefore reducing the danger of large slab-like objects falling onto the high-pressure hose assembly. Under these circumstances, one might contemplate introducing the nozzle through the top of the stack to eliminate possible product collapse altogether. Ensure that the probably debris hidden bottom stack drain is in open position and features an adequate filter of some sort to separate the water from the debris (such as a rock-filled burlap sack). Stack's interior acid resistant brick and grout structure is subject to damage when pressures above 6,000 psi are introduced. The higher water volume applied (mass) combined with long-distance nozzle-jet technology to breach stacks interior diameter ∅ requires a gpm–psi configuration set specifically adjusted to each

Fig. 3.219 3D nozzle

Fig. 3.220 High-gpm 3D nozzle

individual job criteria. A one size fits all gpm–psi setting does not exist due to variance in scale deposits, tensile strength and adhesion factors and the interior distances ∅, from center of a stack to be serviced. Under most circumstances this application will not demand more than 5,500 psi. Higher water volumes are essential to accommodate the nozzle standoff distance (according to the tank-cleaning nozzle employed). The cleaning process is completed in a one-step, one-direction procedure. Repeat practices are unwise and only necessary when the system's pressure volume configuration does not match the jet's rotation and necessary nozzle standoff distance to the stack's internal surface. When considering heights and distances involved, excellent communication between the pump operator and labor force is essential as is fall protection and the use and wearing of top entrance harnesses lanyard security and utilization of safety language instructions, this is not an application suitable for skirmish individuals. Never enter the stack interior while the cleaning equipment is in suspension or operation. Confined space entry permits, lockout–take-out procedures of all equipment connected to stack must be performed establishing safe conditions.

HINT. In operation, tank-cleaning nozzles (Figs. 3.219, 3.220) are often not adequately balanced consequential creating a whipping motion. It is therefore wise

GEAR - LIST AUTHORIZATION

Smoke stacks, laundry shafts and garbage chutes

Customer & Company: Web site: e-mail:		Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			
High-rise building: Power plant: Chemical plant: Refineries:		Commercial ship: Naval ship: Hospital: Other:	
Flame stack: Smoke stack: Ventilation pipe stack:		Garbage chute: Laundry shaft: Other:	
Stack I.D.∅:	Top ∅:	Center ∅:	Bottom ∅:
Chute I.D.∅:	Top ∅:	Center ∅:	Bottom ∅:
Pipe I.D.∅:	Top ∅:	Center ∅:	Bottom ∅:
Concrete:	Brick:	Steel:	Plastic:
Stack platform: Stack ladder: Adequate accessibility: Adequate drainage: Cable reel:		Hazardous materials: Scale product buildup: *Specify thickness:* Other:	
Equipment: H.P. hose: *specify length* Tank cleaning nozzle - controlling line: Lance extensions: Center-mounted roller assembly: Electric winch: Hose clamps: Steel cable: (for correct weight of unit)		Communication radio: Chemicals: *specify* Disinfectants: Deodorizers: Drainage trough: Safety gear: Other:	
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.			

to affix a controlling line to offset this motion to allow sufficient time to depressurize the system (resulting from uneven, worn or contaminated nozzles).

Consider various vertical pipe-cleaning applications when servicing garbage and laundry disposal shafts found in high-rises; generally these shafts are 2 ½′ to 3 ½′ ∅ or square. Above the 5th to 7th floors a 1 ½′ to 2 ½′-pipe diameter reduction is found. Household, office and hotel debris are known to create an

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:	Date: Job Nr.: Address: P.O. Box: City: Zip Code: State:

Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:

Job Description:

Job Location: Job Site Risk Assessment: Specify: ©

Job Review Performed by:

Plant hardware:

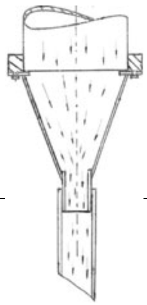
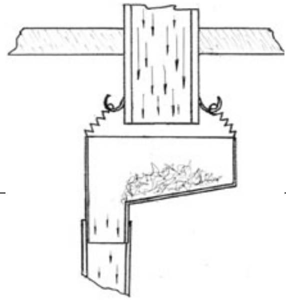


Fig. 3.221 funnel receiver

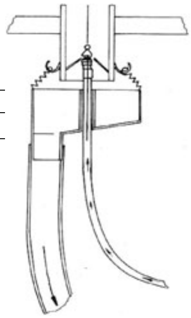
Fig. 3.223 3 D nozzle centralizer

Hydro-blast equipment:



Equipment: Fig. 3.222 open box receiver

Specifications for steel stacks ASME-ST-1 2000



Product Encountered:

Hazardous Material: MSDS: Specify:

Describe application and work procedure:

Various waste stream recovery equipment:

Describe safety procedure:

Itemize equipment, safety gear, expendables, etc.:

Fig. 3.224 pipe cleaning and instantaneous refuse collection

odorous scale which must be periodically removed. In this process the shafts are also chemically sanitized and deodorized. Smooth, straight and easy-to-reach surfaces promise a successful application process.

Hydro-blast units with a large volume capability provide the power to operate a nozzle carrier with six fan tips that are able to completely cover the circumference

of the shaft. The nozzle hose assembly is pulled by rope from the bottom up throughout the pipe's interior. Contractors with smaller mobile units can either pull a custom flex-lance with a standard nozzle, 6 orifices × (∅ gpm?) throughout shaft or clean in increments, depending on the available hose length, from garbage and laundry receiving doors (Figs. 3.221, 3.222, 3.223, 3.224). Disinfectants and deodorizers are metered constantly. Water may be collected in a trough which permits the high-pressure hose or flex-lance to move through its center into the shaft interior. 1,000 psi is generally sufficient in this application and should never exceed 3,000 psi.

3.21 Stationary–Portable Industrial–Commercial Equipment, Vehicle Fleets, Rail–Car, Truck–Trailer–Tanker

Mechanical equipment of any type, which is stored, maintained or operated on open permeable ground should be under scrutiny as to the possibility of oil–grease release creating an ecological endangerment by its petroleum based products essential to its function (Fig. 3.225). In general, producing a known or unknown ground water contamination is in either case regarded illegal when resulting from a process or operation involving oil–grease based content of more then 100th mg per liter water (1 USgal–3.79 L). Protecting the present water conveyance system from accidental release or sloppy maintenance procedures and/or the leaching from contaminated surfaces to the soil of petroleum pollutants is today inexcusable due the general and prevailing education by EPA and various governmental identities as to the inadvertent access of these pollutants to aquifer, rivers and/or lakes. EPA toxic priority pollutants are benzene, cadmium, chromium, toluene, ethylene chloride, mercury, lead, zinc, and copper, to name a few. The pollutants list includes detergents, floatable debris and water turbidity, visible oil and grease sheen, and important to realize, emulsified oils and grease. A contractor must be careful when choosing his cleaning environment, or better location of activity especially in areas where repetitive equipment and vehicle washing operations were a prior sustained activity. Owners of facilities and contractors alike should be aware of the tremendous liability associated with cumulative development in soil conditions (Fig. 3.226). A prior and existing soil contamination at hand does not exempt a service provider. The continued cleaning in one area will result in the buildup of low level contamination to dangerous levels over a period of time and can become obvious due to the introduction of emulsifiers, oil-sheen visually identifiable on surface water runoff or water ground saturation by rain storms, distinctive odor, missing plant life, etc. When considering extended or repetitive cleaning endeavors and/or wash-water cycles within a previous vulnerable location, a savvy contractor guards against possible liability in an unforeseen circumstance by registering and obtaining soil samples prior to any equipment installation or work cycle. The wash water discharge to ground, storm drain or

Fig. 3.225 Oil exploration derrick

Fig. 3.226 Railcar storage line

septic system is a practice of the past. It is the utilization of oil–water separation equipment, minimizing the necessary wash water volume and its contaminant levels combined with a wash water recycling capability which permits servicing on–off road equipment or vehicles and the application of a non-toxic-hazardous environmental degreaser derived from naturally occurring bacteria resulting in colloidal dispersion to biodegradability (enzyme free). This is especially important when cleaning needs on equipment occur which naturally are situated within a sensitive environment subject to scrutiny such as for instance, oil–gas well drilling platforms, their operational support and storage facilities, railcar services on various open track or maintenance areas, or asphalt mixing and paving equipment and/or asphalt breaking equipment, etc. Mobile wash water recovery–recycling equipment and prefab catch basins (Fig. 3.227) including tarp procedures must be of a durable design and provide an installation–removal simplicity minimizing time requirements supporting a contractor in his desire to offer a quick and competitive application.

Railcars can be found nationwide throughout rural areas and are the only vehicular type which will not move over or across a contractor's tarp containment which is typically installed underneath and alongside the railcars track (Fig. 3.228). This advantage eliminates the problematic of puncture by weight and sharp edged gravel substrate.

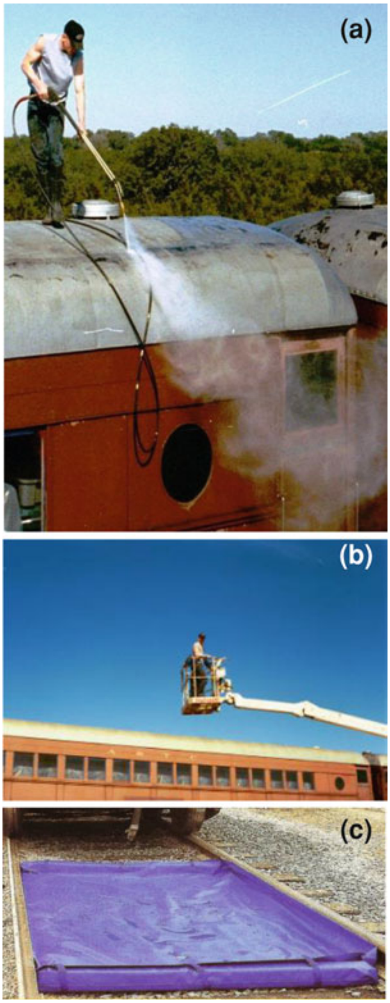


Fig. 3.227 **a** Prep for coating procedure, **b** roof access, **c** prefab wastewater catch basin

Fig. 3.228 Tarp containment, wastewater recovery

The modern locomotive and railcar manufacturing industry has changed its coating technology similar to the automotive and trucking industries. Coating choices are determined by rail car builder, and repair shops, the railroad company itself and private companies identifying their goods and services sometimes choosing a sophisticated coating system. Possibly enhancing their image it is this coating specification, which will dictate gpm–psi, water temperature and chemistry utilized within a wash-down procedure. All railcar coatings can be described as heavy duty, but grime-soiling adhesion to surface interface or resistance to psi–gpm configuration and sensitivity to detergents or chemistry must be evaluated on an individual railcar or unit basis (same identity).

On a lesser coating performance product line, the transition from solvent borne to water borne coating for the exterior of railcars is an environmentally friendly decision in reducing or providing a low VOC content. Another type of new technology is the direct to metal (DTM) low VOC exterior coating systems, which can also be designed for chemical splash and spill resistance requirement, a necessity for tank-rail car units. And a third alternative formulation is a exterior epoxy-urethane coating system designed for railcars providing significantly longer product endurance for the typical harsh railcar environment and can provide or incorporate clear-coat technology. In general, the smoother a rail cars coating surface, the easier and least costly a cleaning procedure due to lesser chemical, filtration–disposal cost and possibly lesser psi–gpm performances, multiplying by two the square footage performance. Easy to clean epoxy-urethane systems are frequently encountered. Evaluating these cars for cleaning times and chemistry depends largely on units' age, and the contaminants penetration into the top surface layer of a coating which includes the possible remnant removal of prior cleaning endeavors and/or statically adhering particulate.

Sophisticated types of interior linings are developed for railcars displacing high back phenolic by lower VOC two-part epoxy products tending towards high-end 100% solids formulation for interior tank linings and covered hopper cars. Operators of railcars carrying food and chemicals have increasingly selected high solid products to protect cargo from contamination. Cleaning these cars is considered a tank cleaning application performed most often in maintenance yards or directly in product manufactures location prior to loading, avoiding confined space entry and its regulations.

Covered hoppers, open top hoppers, gondolas, equipment box or flat cars, refrigerated or plain box cars are generally serviced on elevated maintenance tracks providing sufficient access for the mobile pressure washing recovery and filtration equipment which must include ground-roadway stability for water tank truck and aerial lifts providing railcar roof access. The amount of cars to be washed can be from a few to many, which considers a unit of between 60 and 150 cars of any design from gondola to box-cars. The logistics to deliver necessary detergents-degreaser and blast-water is part the bid proposal (Fig. 3.229), of which requires a careful assessment as to wastewater capture recycling and/or the correct removal to a disposal site. Most cars are cleaned in a two-step process adhering to rail car owners' specification as to the detergent type, dwell time requirement,

Fig. 3.229 Oil–greasy removal before coating

neutralization and possible rinse procedure established prior to the bidding process. When scheduling extensive railcar units (60 plus), down times due to equipment failure or needs, labor exchange, movement of wash water containment equipment and tarp procedures and the correct wash water disposal methods are a part of the general services function. Unplanned deviations, holdups, tardiness etc. cannot be permitted within a job criterion of such magnitude. The time constraints result from estimating precisely necessary cleaning times per car multiplied by 10, resulting in a equipment necessity of two minimum 18 hp hot water pressure-washers utilizing $3/8''$ hose preferably following a detergent applicator down the line.

The supportive prerequisite of moving wastewater and containment including operating aerial lifts for roof washing and its procedure must stay ahead of the washing–cleaning process cycle.

All supportive requirements must never stop or delay the systematic water jetting procedure from bottom up and down, which will also require the crew to correctly manipulate containment from behind (cleaned cars) to cars not yet serviced. Safety meeting and daily tailgate meetings, safety procedures as to making sure that railcars are not moved or engines appear unannounced for this purpose, providing adequate rain gear, signage and flagging in all important locations is a must and will vary with job location.

More often, it is the large bulky and unusual equipment, which are in need of special attention and services (Fig. 3.230). Size, their location and sometimes purpose can require an imaginative application curriculum to provide environmentally correct cleaning procedures which most often will result in an opportunity for equipment specialization.

Fleet washing presents such a specialization curriculum, nowadays only possible and advisable when water filtration and recycling procedures are introduced to a customer's jobsite. There are various opportunities and technical methods available greatly enhancing a potential income through application efficiency in which a fleet can be washed. Ground permeability is the principal deterrent to any washing operation.

Removing petroleum based bulk grease, fats and oils from obvious vehicle areas is a simple application criterion where high-pressure hot-water velocity is indispensable (Fig. 3.231). Finding a one size fits all road film removal technique can instead be frustrating. Herein lie's the problem. The complexity of soils due to

Fig. 3.230 **a**, **b**, **c** Specialty heavy transporter

Fig. 3.231 **a**, **b**, **c**, **d** Various track chassis

their varying affinity to oil or water adhering to a variety of surfaces can be surprising. If a soil shows water-solubility the process to clean with high-pressure water is successful in bulk removal and to the extent that only ionic and/or statically charged film-particles adhering to a coated surface are removed in a jetting-combined physical procedure (brush). Within this scenario the detergent-acid application is minimized. Soils containing fatty–oily residual require a cleaning method producing water solubility. Therefore removing road film can only be achieved in combining water velocity with a chemical reaction by changing oily soil molecules into a water soluble road film to sever its bond to the coating surface interface. This is also where hot water equipment is of an advantage activating detergents with a low or high pH. Phosphate, silicates, citrates and polymers are examples of chemistry which will bond to soil particulate rather than to a coating surface. This supports applied water velocity to break particulate bond to the coating interface surface. This is quite a simplistic analysis and must be delicately manipulated according to fleet's circumstance, its vehicle and coating design and purpose. Cleaning a tractor–trailer fleet will be quite site specific when general road film and diesel stack-exhaust deposits (carbon), or grease accumulation on the running gear must be removed and/or a product oriented cleaning endeavor subject to a trucks utilization is required. The chemical supplier, promising, a one size fits all product must be met with suspicion.

Dump trucks, box trucks, and aluminum or stainless steel tankers, etc. always vary in their applicable chemistry.

Detergents for cleaning heavy duty tractor trailers, to aluminum brighteners, heavy-duty engine and tire degreasers which may include a brake dust and carbon-diesel soot deposit removal formulation, and/or applying polymeric hot or cooled mix release agents to cleaned vulnerable truck surfaces facilitating asphalt tar-pitch release etc. can be a job description specific to a customer which does not deserve a chemists generalization (Fig. 3.232). The correct utilization of a reclaim detergent designed specifically to support water–oil separation and filtration units' technical aspect can also cloud a perception of functionality due to its naturally low foaming formulation. Also the equipment to apply the necessary chemistry must be considered which is important to provide sufficient dwell times in consideration of their necessary rinse cycles concerning overall truck–trailer cleaning efficiency. Services sales endeavors are most likely only successful due to a potential customer's past inconsistent and unreliable fleet washing experiences. Fleet managers are usually very loyal to an existing service provider. They generally recognize the problems a mobile fleet washing company encounters. Inexperience, resulting in incorrectly identifying a fleets design and cleaning criteria can also be the downfall of a novice service provider, especially when combined with a customer's possible wishful thinking concerning today's simultaneous wash-water recovery–recycle procedures, and their possible disposal and price implications. The service provider must also clarify within his proposal as to the extent of detail performance his services will include. Are windows to be washed and dried and to which degree engine compartments must be detailed, etc. (Figs. 3.233, 3.234, 3.235, 3.236)

Fig. 3.232 **a**, **b**, **c**, **d** Various and varying truck chassis

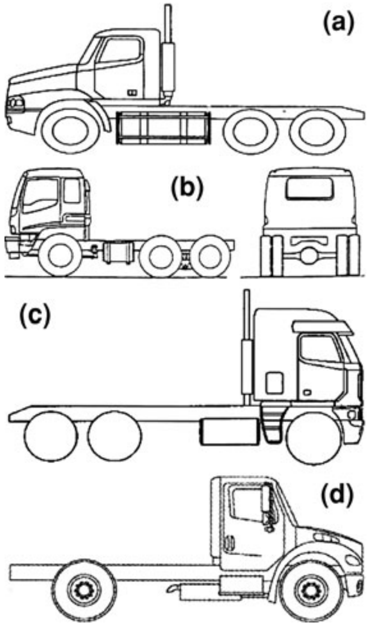
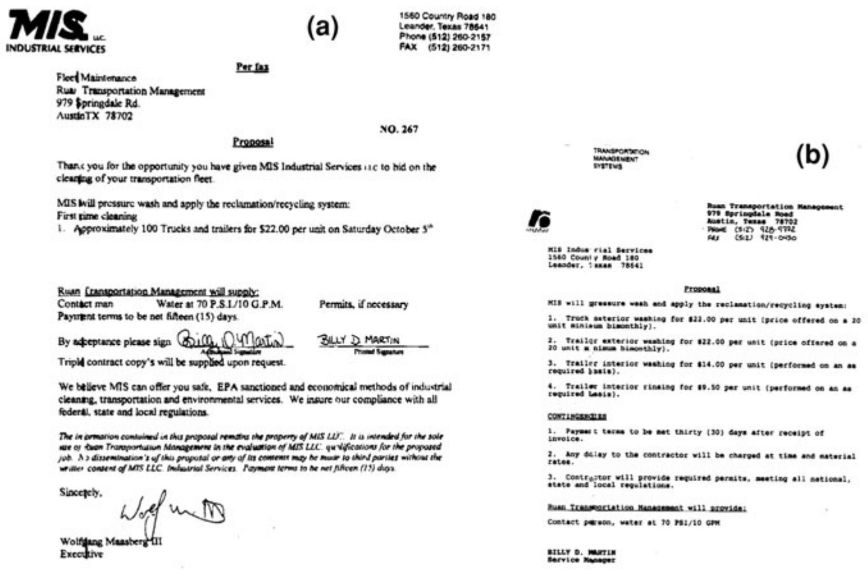


Fig. 3.233 Wash water recycling

Fig. 3.234 Truck washing

Commercial fleet owners may require detailing services consisting of interior shampooing, cleaning of floor mats and windows, which at best is a tedious and impractical application criteria when it must be considered in fleet washing proposal procedures. The interior detailing criteria is generally not a part of an exterior fleet washing operation. Exterior detailing includes buffing and polishing



(a)

MIS LLC INDUSTRIAL SERVICES

1560 Country Road 180
Leander, Texas 78641
Phone (512) 260-2157
FAX (512) 260-2171

Per fax

Fleet Maintenance
Ruan Transportation Management
979 Springdale Rd.
Austin TX 78702

NO. 267

Proposal

Thank you for the opportunity you have given MIS Industrial Services LLC to bid on the cleaning of your transportation fleet.

MIS will pressure wash and apply the reclamation/recycling system:
First time cleaning
1. Approximately 100 Trucks and trailers for $22.00 per unit on Saturday October 5th

Ruan Transportation Management will supply:
Contact man Water at 70 P.S.I./10 G.P.M. Permits, if necessary
Payment terms to be net fifteen (15) days.

By acceptance please sign Billy D Martin (Authorized Signature) BILLY D MARTIN (Printed Signature)
Triple contract copy's will be supplied upon request.

We believe MIS can offer you safe, EPA sanctioned and economical methods of industrial cleaning, transportation and environmental services. We insure our compliance with all federal, state and local regulations.

The information contained in this proposal remains the property of MIS LLC. It is intended for the sole use of Ruan Transportation Management in the evaluation of MIS LLC qualifications for the proposed job. No dissemination's of this proposal or any of its contents may be made to third parties without the written consent of MIS LLC Industrial Services. Payment terms to be net fifteen (15) days.

Sincerely,

Wolfgang Maasberg III
Executive

(b)

TRANSPORTATION MANAGEMENT SYSTEMS

Ruan Transportation Management
979 Springdale Road
Austin, Texas 78702
PHONE (512) 928-9792
FAX (512) 929-0450

MIS Industrial Services
1560 County Road 180
Leander, Texas 78641

Proposal

MIS will pressure wash and apply the reclamation/recycling system:

1. Truck exterior washing for $22.00 per unit (price offered on a 20 unit minimum bimonthly).

2. Trailer exterior washing for $22.00 per unit (price offered on a 20 unit minimum bimonthly).

3. Trailer interior washing for $14.00 per unit (performed on an as required basis).

4. Trailer interior rinsing for $9.50 per unit (performed on an as required basis).

CONTINGENCIES

1. Payment terms to be net thirty (30) days after receipt of invoice.

2. Any delay to the contractor will be charged at time and material rates.

3. Contractor will provide required permits, meeting all national, state and local regulations.

Ruan Transportation Management will provide:

Contact person, water at 70 PSI/10 GPM

BILLY D. MARTIN
Service Manager

Fig. 3.235 **a**, **b** Proposal to fleet management

Fig. 3.236 Washing operations, 8 min per truck–trailer unit

painted surfaces, polishing all of the aluminum including bumpers etc., preparing windows and mirrors, which again is an application not often successfully combined with a high intensity pressure washing operation successfully cleaning a tractor–trailer unit within 8–10 min (correct equipment set up). Some contractors do operate an independent crew for detailing requirements, which can follow exterior wash operations. Due to vehicle variety and variable conditions, a proposal for interior and/or exterior detailing services is best established independently from fleet washing operations. Maintenance requirements, fleet scheduling, tractor–trailer access to wash area, educating drivers as to parking requirements and correct spacing on non-permeable parking surfaces, centralized wash water recycling and vacuum shoe recovery position (Fig. 3.237), isolating possible ditch-storm drain and truck delivery-dock drain systems, etc. and providing electricity or light access for possible night work are a general job description which must be integrated to the bid procedure. Any unforeseen deviations will result in tremendous time losses quickly becoming a big business problematic with unhappy consequences. Most tractor–trailer fleet operations are time cognizant with varying

Fig. 3.237 Vacuum shoe, bladder berm

degrees of emergency procedures requiring a service provider to accommodate job flexibility. Within a proposal procedure these possibly varying degrees of emergencies, arrival and departure times must be addressed to facilitate operational harmony. Vehicles are identified by vehicle number which is best combined with the license plate number, alleviating possible confusion when record-keeping. Trucks are likely to be cleaned twice monthly, including offering an emergency cleaning standard of one or two units per pay period. Fine tuning operations and equipment should be a quarterly-seasonal endeavor, which is also specified within a negotiated contract.

Due to changing variety of temperature or seasonal influences, creating varying diverse layers of road film, dirt, ice, carbon and salt deposits, including insect accumulations on radiators, vehicle hood and window surfaces, etc. must be a criterion carefully dissected within a contract negotiation. These factors will also affect the efficiency of detergents, as does the hot water temperature requirement up to or between 140 and 160°F. The distance between parked trailers must accommodate the length of the high pressure wand and its angulations between trailers.

When distance is too close (<7′) it will severely hinder washing procedures, resulting in time losses and annoyed wand operators. There are various ways of recovering wastewater simplified when non permeable asphalt or concrete surfaces are designated for washing operations. To assist this can require a permanent water dike constructed in a strategic water runoff area by inexpensively placed road asphalt creating a dike effect permitting a vacuum shoe fixture to its lowest elevation. For drive-through operations a wash pad mobile catch basin, for wash water recovery from trailers and containers a mobile catch basin attached to or placed underneath the rear trailer area allowing a practical application solution. This type of wash water control is very effective, especially when cleaning farm, off-road machinery, construction equipment and railcars, etc. Water filled storm sewer wrap-cover and portable dike systems of various lengths, facilitating custom designed water run-off control on non permeable concrete or asphalt surface designated for cleaning operations with a vacuum shoe placed in its lowest elevation, or the utilization of a vacuum boom which are also applied in parking areas, gas stations, bank and restaurant drive-thru cleaning applications. Services applying a closed-loop wash water recovery system can consider tractor, tractor–trailer the standard revenue initiator which is adjusted upwards when washing cement trucks, garbage and equipment trucks and attains its top revenue potential

GEAR - LIST AUTHORIZATION

Stationary-portable, commercial equipment, vehicle fleets, rail-car, exterior truck-trailer-tanker

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify: ©	
Job Review Performed by:			

Tractor: Sleeper: Trailer: Tanker: Container: Railcar: Unit: Tanker, hopper, gondola : Other: Business-medium duty truck: Light-truck: Type: Equipment: Equipment location: Other:	Nr.:		Permeable grounds: Non-permeable grounds: Asphalt: Concrete: Sump-pump: Wash pad: Explain: Portable wash pad: Portable wastewater containment system: Portable sewer cover: Portable water dike system: Length in feet: 50 gallon vacuum separator-transfer barrel: Vacuum box: Other:		
Equipment: Chemicals: *Specify:* *MSDS:* *Two-step method:* *Metering method: upstream-downstream* Foam nozzle-injector: Hot water: Cold water: Water recovery: Closed-loop reclaim process: Vacuum hose: (Feet) Vacuum shoe: Other: Type of soiling-contamination:			Nozzles: 15°, 25°, 45°, 65° High-pressure trigger gun: High-pressure trigger gun: duel wand: Wand-lances: Extension: 5’, 6’, 8’ High-pressure hose: ¼”, ”, ½”, Rotary jet: Soft bristle brush: Extension: 6’, 8’’ Box rags: Flashlight: Other:		

Product hardness, adhesion, viscosity:	*Specify:*	
Fouling characteristics:	*Specify:*	
Physical surroundings, safety procedures:	*Specify:*	Others:
Describe application and work procedure:		
Itemize further equipment, safety gear, expendables, labor and equipment times, etc.		

when servicing oil and gas tankers at approx. $45.- and/or individually priced specialty transporters at time and cost. Environmentally washing and specializing in pressure washing and hydro-blast application technologies offers many business opportunities in commercial and industrial environments.

3.22 Tanks, Vessels-Autoclaves, Precipitators, Container Cleaning, Volatile Substance Removal and Effluent Separation

In the early 1920s, cleaning applications for tanks and vessels applying centrifugal water pump pressure brought about the development of rotary 2D and 3D nozzles utilized to clean, and/or material slurry achieving a product thinning or agitation process. Companies such as Butterworth, Sugino, Lechler and various European manufacturing identities were actively involved in a design criterion facilitating performances between 15 and 350 gpm at pressures of up to 250 psi.

The jetting medium can be hot and cold water admixed with detergents or liquid petroleum product developing a jet stand off distance up to 90′. Especially in foodstuff, pharmaceutical and maritime industries (tanks-barges), has this development drastically reduced man entry to vessels. In 1967, with the development of hydro-blast equipment operating above 5,000 psi to 10,000 psi delivering up to 75 gpm, WOMA designed and patented various 2D and 3D nozzle configurations (Fig. 3.238) operating within this performance criteria which included a 3D dual head assembly with four jetting orifices (Figs. 3.239, 3.240).

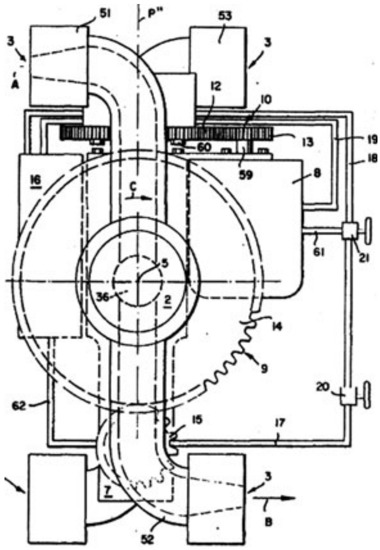


Fig. 3.238 Twin rotor jetting 3D nozzle

Fig. 3.239 Twin rotor jetting 3D nozzle patent abstract

[57] **ABSTRACT**

An apparatus for the cleaning of the internal surfaces of receptacles of substantially any configuration and type comprises a head rotatable about the axis of an inlet conduit for the cleaning fluid and carries at least one rotatable nozzle arrangement having tangentially oriented nozzles communicating via the head with the conduit for rotation of the nozzle member upon ejection of the cleaning fluid through the nozzles thereof. A hydraulic motor is coupled with the head for rotating the same about the conduit axis and relatively thereto, the motor being driven at an adjustable rate by fluid delivered by a hydraulic pump coupled with the nozzle box and driven thereby.

Assignee: **Woma-Apparatebau Wolfgang Maasberg & Co. GmbH, Rheinhausen, Germany**

Filed: **Sept. 14, 1970**

Appl. No.: **71,959**

Foreign Application Priority Data

Sept. 13, 1969 Germany....................P 19 46 500.0

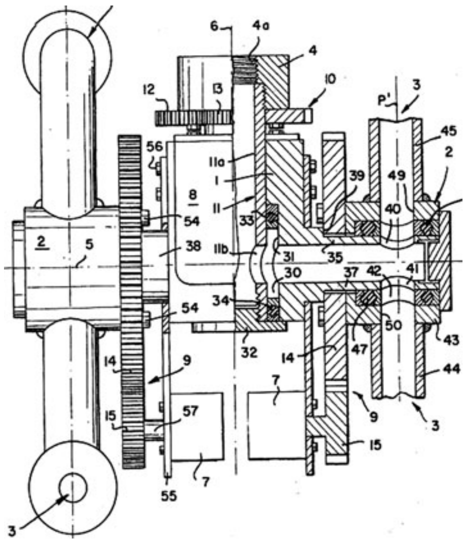


Fig. 3.240 Twin rotor 3D nozzle partial view

Today a contractor can classify cleaning techniques for tanks and vessels into three categories. The dedicated cleaning systems are permanently installed to interior of vessels and tanks. A wide variety of cleaning heads are available, where the simplest is a spray ball, either fixed or rotating powered by the pressurized water or liquid passing through its jetting offices. Pressures range from 40 to 500 psi with wide ranging gpm performances necessary for softer deposits found in foodstuff and pharmaceutical industries achieving product agitation or cleaning procedures. The water-pressure source is often generated by a centrifugal pump

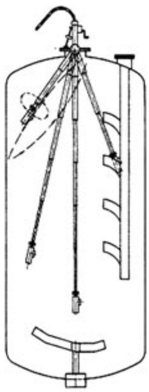


Fig. 3.241 Telescope fixture

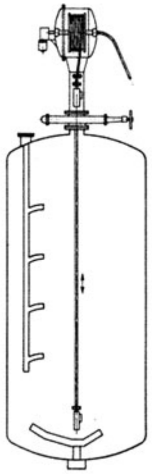


Fig. 3.242 Hose-reel nozzle descend

(multi-stage) capable of developing up to 500 psi and gpm performances pending on horsepower-input (Figs. 3.241, 3.242).

Dedicated cleaning systems for process vessels in chemical industries are often utilized for closed reaction processes where V.O.C. and other emissions must be fully contained. Typically cleaning pressures range from 3 to 8,000 psi powering self-propelled, 2D or 3D nozzle stored in a gas neutral chamber above a process and lowered in increments by hose reel, telescope fixture or hydraulics at predetermined cleaning cycles either computer or manually controlled. Due to the nature of a manufacturing process these systems are normally operated on a daily or weekly basis. Besides, today mass produced beer barrel and soft drink container cleaning systems are another example of a dedicated cleaning heads, which are system as is equipment designed to demilitarize warheads-bombs and solid rocket fuel shells and/or motors.

This stationary equipment operates between 8 and 12,000 psi at comparatively low water volumes. Rotating shell and/or cutting nozzle-lance assemblies to

Fig. 3.243 Incremental adjustment

remove propellant from the interior of shells and bombs directly delivering irregular refuse debris and jetting water to a macerating unit which can be either a mechanical process or a whirl-jet chamber preparing the arriving refuse for the water recovery–recycling and filtration function attaining a product separation into the basic constituents, which are probably highly classified (Fig. 3.243).

All due to their portability, rotary head cleaning systems are the most popular with contractors providing the important application flexibility throughout the commercial–industrial environment. Tank entry can often be avoided, especially with process equipment, autoclaves-reaction vessels, mist eliminators, precipitators, stacks, etc. The successful application of these rotary heads and their adjustable installation equipment depend on correct nozzle placement and path within a vessel. Position the 3D tank-cleaning nozzle at the center of the vessel approximately ¼ of the distance from the top to the bottom. Adjustable nozzle armature permits the offsetting to the directly overhead shadow area in increments of the nozzle's half circumference as can the depth to the bottom of unit be adjusted as the cleaning procedure progresses (Fig. 3.244).

Generally residual film of a liquid grows thicker to the bottom of a tank where the washing or product cutting effects must be the most pronounced, which include the areas of farthest corner's, vessels liquid inlet and structural discharge orifices which are often obstructed by prematurely hardened-viscous liquid product. The distance and starting point of a nozzle should be approximately one quarter of the jets effective cleaning–cutting radius. Standing liquids and residual resulting from a plugged or closed discharge valve will dramatically diminish liquid jet power

Fig. 3.244 Telescope adjustment

Fig. 3.245 Static affixed 3D nozzle

and cutting capacity. The hydro-vac system directly connected to a discharge flange will greatly enhance product movement and further macerate the dislodged debris when stirring through the jet pump's concentrated liquid ring piston. This is only possible when the vessel is open to the atmosphere. The longest standoff distances and strongest product hardness, tensile strength and adhesion will most often appear in the bottom corners and coldest or lowest velocity areas of any interior vessel (Figs. 3.245, 3.246, 3.247). The effective jetting performances must be calibrated to these areas by manipulating nozzle's standoff distance, psi–gpm performance and most importantly, utilizing interior cone-shaped nozzle designs facilitating a tight water-jet formation (Bernoulli).

Tank trucks and rail tankers (Figs. 3.248, 3.249) can be of interest to a contractor due to a wide variety of products shipped. Adhering product residue must be removed when an alternative liquid cannot be contaminated by remaining

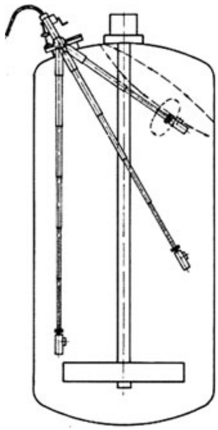


Fig. 3.246 Telescope nozzle arm

Fig. 3.247 3D hydro-blast nozzle

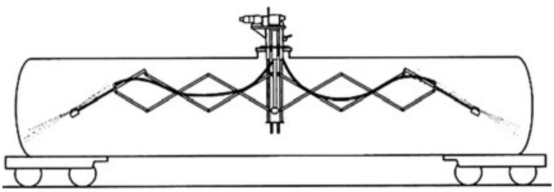


Fig. 3.248 Rail-tanker 3D scissor arm, travel adjustment

residue of a prior load. Various nozzle fixtures are available to accommodate the mounting to a tank flange.

Nowadays it is not a question that high-pressure water is capable of removing urea calcifications, etc. The question must first be as to the structural integrity and the tanks base material, its thickness and type. Nozzles can operate up to 24,000 psi (plus) and must be adjusted to avoid damage to a tankers skin, lining or coating.

Encountered products tensile strength and adhesion to surfaces, elasticity, viscosity and varying brittleness within fluctuating high heat manufacturing processes and the variety of process equipment, their age, design, efficiency and failure rate, interior varying surface sensitivities such as for instance interior

glass-lined autoclaves are the guidelines as to determine a correct psi–gpm performance criteria, resulting in the choice of the most effective nozzle apparatus for the individual technical circumstance encountered. Performance generalizations as to a typical removal criterion of natural or chemical processes deposits will always lead to an unreliable estimation. The relationship between applicable psi and gpm ratios toward a specific product removal criterion will always change within a process requirement (Fig. 3.250) or its failure and its varying surface interface structure, ambient temperature and encountered process equipment's physical and/or hardware design features. On this note, guidelines can be established and are derived from experience:

Asphalt–bituminous splatter at temperatures between 45° and 70° on concrete-steel surf.	5,000–8,000 psi
Alkyd resins at temperatures between 45° and 70°	8,000–2,000 psi
Concrete cutting, abrasive assist at temperatures between 45° and 70°	10,000–4,000 psi
Concrete residual at temperature between 45° and 70°	4,000–2,000 psi
Coke product accumulation (refineries) at temperatures between 45° and 70°	12,000–22,000 psi
Crude oils at temperatures between 45° and 70°	1,000–3,000 psi
Butadiene styrene at temperatures between 45° and 70°	6,000–12,000 psi
Calcium-carbonate	5,000–7,000 psi
Epoxy resins at temperatures between 45° and 70°	10,000–14,000 psi
Emulsion polymers at temperatures between 45° and 70°	10,000–14,000 psi
Food processor residual at temperatures between 45° and 70°	3,000–10,000 psi
Fermentation residual at temperatures between 45° and 70°	3,000–10,000 psi
Isocyanate, MDI & TDI at temperatures between 45° and 70°	10,000–14,000 psi
Latex (green state) at temperatures between 45° and 70°	3,000–6,000 psi
Latex synthetic, at temperatures between 45° and 70°	6,000–14,000 psi
Light oils (turbine oil) at temperatures between 45° and 70°	1,000–3,000 psi
Methyl Methacrylate at temperatures between 45° and 70°	6,000–14,000 psi
Phenolic resins at temperatures between 45° and 70°	8,000–14,000 psi
Polycarbonate at temperatures between 45° and 70°	6,000–10,000 psi
Poly vinyl chloride at temperatures between 45° and 70° (PVC)	4,000–10,000 psi
Poly vinyl acetate (PVA) at temperatures between 45° and 70°	6,000–10,000 psi
Paint dried solvent based at temperatures between 45° and 70°	6,000–10,000 psi
Paint epoxy at temperatures between 45° and 70°	10,000 psi to UHP performance
Paint solvent based at temperatures between 45° and 70°	12,000 psi to UHP performance
Vinyl emulsion polymers at temperature between 45° and 70°	8,000 psi to UHP performance

In layman terms the psi performance is set to cut a material to the interface adhesion point supported by the gpm performance (water-mass-horsepower-input) offering increased explosive surface area to the high velocity water mass.

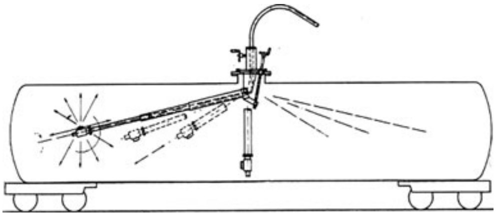


Fig. 3.249 Rail-tanker 3D telescopic travel

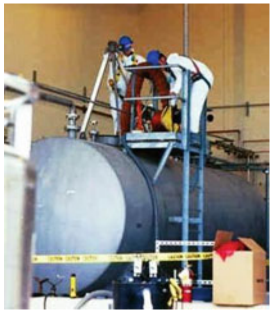


Fig. 3.250 Tank cleaning, top entrance

Fig. 3.251 **a**, **b** Air-preheater basket

Therefore the necessary indication of psi will never reveal the efficiency of any job description, performance and/or adequacy in surface appearance.

This fact becomes very obvious when utilizing mobile 2D or 3D nozzles cleaning distillation trays, cyclone separators and mist eliminator baskets of various designs. The psi performance cuts through the first layers of deposits, facilitating a surface area for the water mass to deeply penetrate throughout an encrusted pack or mesh mist eliminator structure (Fig. 3.251, 3.252) and/or the depth of a fin-fan cooler.

Glass-lined pharmaceutical plant vessels (Fig. 3.253) must be handled with care, in that direct pressures to a lining should not exceed 6,000 psi. The pressure produced by nozzle restriction diminishes its impact rapidly when released into the atmosphere. A 6,000 psi pressure gauge reading may diminish to 3,000 psi at a 3-ft nozzle stand-off distance. Glass linings are more susceptible to damage by

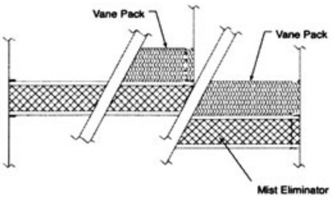


Fig. 3.252 Mist and vane pack structure

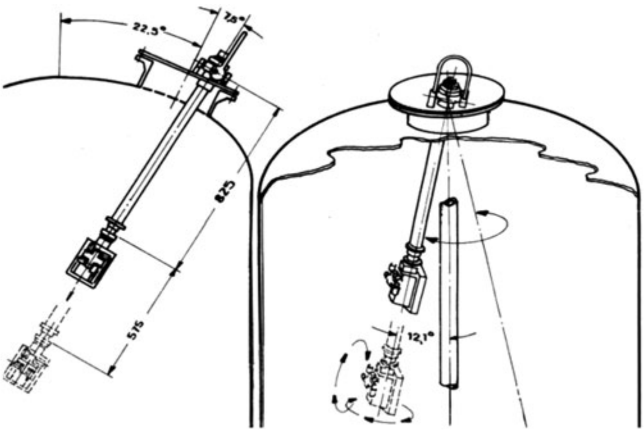


Fig. 3.253 Top and side telescope tank access

metal tools dropping accidentally. Nevertheless tank liners must also be protected from imbalanced jetting heads avoiding damage by possible impact. The larger the vessel, the greater will be the flow (gpm) to achieve necessary jetting velocity to remove various caked products.

Cooperation of the pharmaceutical and/or chemical plant engineering department is of utmost importance to identify their vessels structural interior design, which can include baffles, props of various sizes, heating elements and intake–discharge fixtures to permit a correct 2D or 3D nozzle navigation. Continuously removing product and sludge can be achieved by applying the hydro-vac system. This is made possible by introducing an air intake fixture (isolated or open), to the vessel flange man access providing positive air flow to degas toxic vapors simultaneously within the cleaning and sludge removal process of vessels airborne toxic-volatile organic compounds. Volatile emissions can be controlled removed and separately treated as to plant specifications. Safety must be a never ending concern. A no-entry vessel cleaning procedure must not provoke negligence concerning the possible prior content of a vessel being cleaned. Its trace elements contaminating nozzle assembly can require a decontamination procedure. Customers should never be trusted as to their purging, neutralizing and cleaning endeavors. Hazardous verification, identification and classification of

products must be a known to the contractor and independently verified facilitating the correct identification of safety procedures, gear and equipment.

Qualifying in confined space entry procedures will open a substantial and highly profitable commercial–industrial application opportunity. Commercial and industrial service companies applying pressure washing equipment all too often misjudge this business potential. As to the identification of a confined space, Washington's is the most concise and says that a confined space is any space having a limited means of egress which is subject to the accumulation of toxic or flammable contaminant or an oxygen deficient atmosphere. Applying high-pressure water as a tool with its wide variety of applications, utilizing abrasive blast methods, sludge or product removal by hydro-vac equipment operating injectors as pump identity or employing product separation by a vacuum container and/or pump truck, sewer and pipe cleaning endeavors, coating removal and surface preparation exploiting the UHP method and its manual and automated equipment, or a combination of all will require all applicable safety variations established by the American National Standards Institute (ANSI-Z-117.1-1989) and its bylaws. The National Institute for Occupational Safety and Health (NIOSH), defines a confined space which by design, has limited openings for entry and exit, unfavorable natural ventilation, which could contain or produce dangerous air contaminants, and which are not intended for continuous human occupancy. NIOSH also acknowledges that varying degrees of hazard may exist under different conditions by describing three separate classes of spaces, namely class A, B, and C. For a contractor it is most important to realize that OSHA's general industry definition for confined space requiring a permit (OSHA-29 CFR 1910.146) does also include regulations for OSHA's maritime, agricultural, construction definitions and is regulated by a different part of the Code of Federal Regulations (CFR), which are also established for paper mills, telecommunications, chemicals and allied products, primary metals industry, motor freight-transportation, wastewater treatment facilities, etc. and does consider confined space variations in size, shape and function.

Within its facets, the mere involvement, and study for confined space entry will produce an application criteria of tremendous variety within the commercial, industrial, marine and agricultural environment.

A confined space is not necessarily totally enclosed. An open tank-vessel without a roof structure is also considered a confined space, especially when the job requires agitation or removal of hazardous materials possibly emitting volatile or toxic vapors, the access to this space is limited, and is normally not occupied by people.

The cleaning of natural latex product from such an open vessel may stipulate as shown (Figs. 3.254, 3.255, 3.256, 3.257).

Another such space, normally not occupied by people are wastewater treatment facilities clarifiers which also require a confined space entry permit (OSHA 20 CFR 1910.146). Wastewater treatment facilities (Fig. 3.258) are prone to hydrogen sulfide enriched atmospheres which must be guarded against and continuously tested for.

SAFETY CLEAN UP SHEET

NATURAL LATEX

Unusual Precautions: 1) Latex contains ammonia as a preservative and is an irritant

Safety Equipment Required: 1) Gas mask with ammonia vapor canister
2) Rubber gloves
3) Apron or coveralls

Clean up Materials: 1) Calcium nitrate salts for coagulation
2) Mop and water
3) Waste container

Clean up Procedure: 1) Put on required safety equipment specified above
2) Sprinkle calcium nitrate crystals over spill to coagulate latex
3) Roll and peel coagulated film from floor and place in waste container
4) Mop area with soap and water

Disposal Technique: 1) Dispose of material as solid waste in land fill

Medical Attention: 1) Eye and skin contact should be flushed with water
2) Inhalation of vapor (ammonia) should have medical attention

Fig. 3.254 Plant supplied safety cleanup sheet

The contractor operating only one hydro-blast unit to slurry sludge chooses to utilize a sludge pump versus the hydro-vac system. His experience with fly ash (Mt. St. Helens) and admixed city clarifier sludge which proved susceptible to high velocity high pressure water jets emulsifying and causing liquid to free flow at an astonishing effective rate did not justify the mobilization of an additional hydro-blast unit nor industrial vacuum truck operation. Two trigger-gun affixed $^3/_8{}''$–$8'$ T lance assemblies with four slurrifying nozzles were responsible to complete this job in record time.

Confined space hazards are: oxygen deficient atmospheres, oxygen enriched atmospheres, “toxic” or irritating atmospheres.

Physical hazards are: fixed and portable mechanical equipment sensitive to fogging or water misting, electrically energized conductors, fluids–liquid such as oils diminishing adequate footing, powders and gases, thermal conditions hot or cold creating fog or misting events limiting visual orientation, engulfment by finely divided material, ionizing and non-ionizing radiation, contact with various chemicals and corrosive substances.

Mist eliminators in fossil fueled power plants are serviced by hydro-blast jetting technology by cleaning the mesh structure free of lime and calcium accumulations which will also deposit on intake surfaces, undersides of baskets and vessels

SANITATION SCHEDULE ESTIMATE
CONFINED SPACE ENTRY

All numbers are estimates and subject to fluctuation.

Scheduled Sanitation:	Crew[1]	Hours[2]	Task[3]
Each Week, Monday			
1 - Scrubber	1	4	High pressure water wand. clean sump with wet vac.
1 - Latex tank, sm	1	1	Low pressure cold water. Scrub down walls manually.
2 - Dip tank	3	2	Low pressure cold water, flush. Manually scrape tank sides, bottom.
Each Week, other than Monday			
1 - Latex tank, lg	3	6	Manually scrape and collect "dry" latex
Each 6 Months			
4 - Scrubbers	1	4	
4 - Water tank	1	1	Rinse with low pressure cold water
5 - Latex tank, sm	1	1	Low pressure cold water. Scrub down walls manually.
10 - Dip tank	3	2	Low pressure cold water, flush. Manually scrape tank sides, bottom.

Unscheduled Sanitation: as required.

[1] Not counting attendant

[2] Hours for designated crew size to clean one unit.

[3] All entries include removal and replacement of covers or manholes for access.

Fig. 3.255 Plant supplied sanitation estimate, confined space entry

bottom including possibly the smokestacks intake surfaces (Figs. 3.259, 3.260, 3.261). If not utilizing suspended automated cleaning equipment while in a plant shutdown mode, the manual cleaning method is still very compatible within the overall job description requiring cleaning the complete vessel from top to bottom. Nozzle rigging times, unequal deposits throughout a basket structure, requiring repetitive cleaning cycles, expense of excessive horsepower input and the operation of basket disc structure are time-consuming, often eliminating the advantages gained by remote basket cleaning operations.

Pressures range between 8,000 and 10,000 psi to 26 gpm for basket cleaning which can be reduced to approximately 6,000 to 8,000 psi for vessels interior surface cleaning applications. Bottom accumulated bulk debris is shredded (Fig. 3.262) to fit a hydro-vac vacuum shoe substantially outperforming industrial vacuum truck loading capacities especially when an alternative material disposal sequence is required. The product can be dry loaded utilizing a centrifugal separator, or macerated to be vacuum transferred to a settling or evaporation pond or

UNITEX / DYNATEX
MALAYSIAN
NATURAL CENTRIFUGED LATEX

CERTIFICATE OF ANALYSIS SHEET

PER S/S SHOUN MARU LOT NO.

GENTLEMEN:

We list below our specifications covering__________ GALLONS of latex being shipped __________ from __________ via __________.

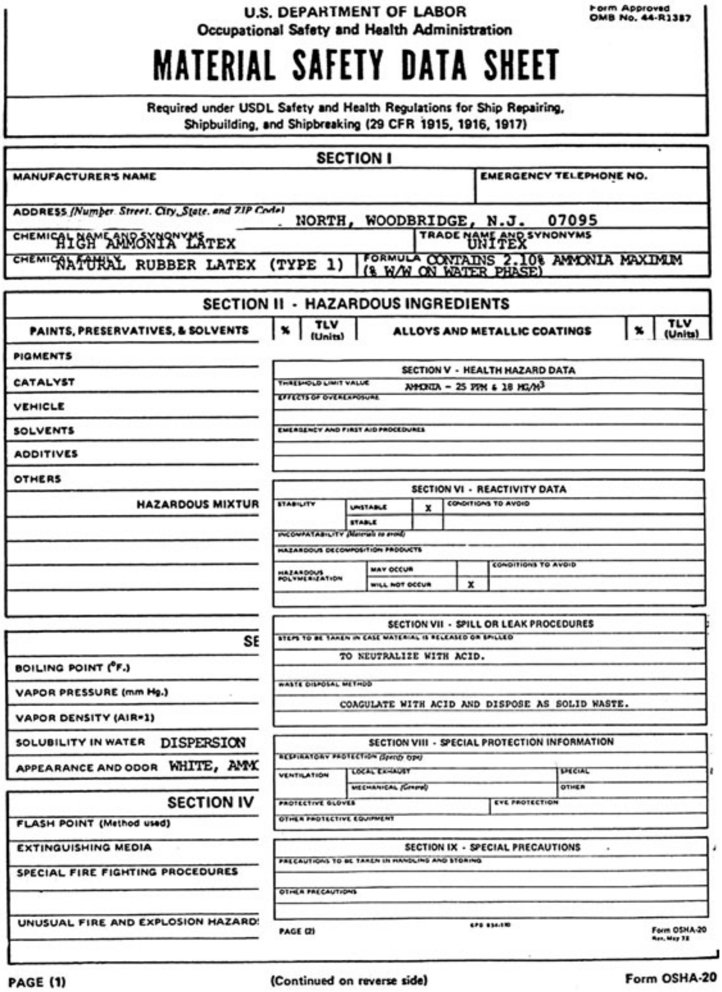
A)	Total Solids (T.S.)	61.82
B)	Dry Rubber Content	60.38
C)	Total Alkalinity (Calculated as NH3 expressed as a percent on water phase.)	1.82
	(Calculated as NH3 expressed as a percent on Latex Phase.)	0.76
D)	PH	10.55
E)	Sludge Content - % of wet weight	Neg.
F)	Coagulum Content - % of T.S.	0.008
G)	KOH Number	0.63
H)	Mechanical Stability (MST) - (seconds) @ 55% T.S.	1075
I)	Color on Visual Inspection	WHITE
J)	Odor (Boric Acid)	N.P.
K)	Brookfield Viscosity - Centipoises (@ 60% T.S. @ 25 C.)	78
L)	Surface Tension	39.7
M)	Soap	0.05
N)	Copper	Less than 2
O)	Manganese	Less than 2
P)	V.F.A.	0.14
Q)	Magnesium (PPM on T.S.)	20 - 25

Fig. 3.256 Plant supplied product identification and certification of analysis

directly loaded to an open watertight dump truck delivering the debris-sludge after its simultaneous water recovery function to a landfill. Care must be taken when jetting tank walls and elevated discharge areas. It is important to first determine built up accumulations before a scaffold is put in place.

The high-pressure water gun operator must make sure that an inadvertent and uncontrolled release of overhead and overhang products above scaffold will not under any circumstance risk stability of the trigger-gun operators platform. OSHA's fall protection requirements within a confined space must be adhered to and are identified under OSHA subpart M 1926.500 technicians walking–working with an unprotected side that is 6′ or more above lower level must be protected from falling by guard rail, safety net or personal arrest system.

Cleaning aboveground storage tanks (Fig. 3.263) can include all exterior–interior surfaces including dome roofs', or floating roofs seal and drain systems and/or suspended internal deck systems including their components. Heating elements often encountered in the northern hemisphere can be surprisingly complex in an application requirement which demands a full light illumination



U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Form Approved
OMB No. 44-R1387

MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

SECTION I

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, and ZIP Code) NORTH, WOODBRIDGE, N.J. 07095	
CHEMICAL NAME AND SYNONYMS HIGH AMMONIA LATEX	TRADE NAME AND SYNONYMS UNITEX
CHEMICAL FAMILY NATURAL RUBBER LATEX (TYPE 1)	FORMULA CONTAINS 2.10% AMMONIA MAXIMUM (% W/W ON WATER PHASE)

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS					
CATALYST					
VEHICLE					
SOLVENTS					
ADDITIVES					
OTHERS					
HAZARDOUS MIXTUR					

SE

BOILING POINT (°F.)	
VAPOR PRESSURE (mm Hg.)	
VAPOR DENSITY (AIR=1)	
SOLUBILITY IN WATER	DISPERSION
APPEARANCE AND ODOR	WHITE, AMM

SECTION IV

FLASH POINT (Method used)

EXTINGUISHING MEDIA

SPECIAL FIRE FIGHTING PROCEDURES

UNUSUAL FIRE AND EXPLOSION HAZARD

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE AMMONIA – 25 PPM & 18 MG/M³

EFFECTS OF OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE	X	CONDITIONS TO AVOID
	STABLE		

INCOMPATABILITY (Materials to avoid)

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

TO NEUTRALIZE WITH ACID.

WASTE DISPOSAL METHOD

COAGULATE WITH ACID AND DISPOSE AS SOLID WASTE.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)

VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (General)	OTHER

PROTECTIVE GLOVES | EYE PROTECTION

OTHER PROTECTIVE EQUIPMENT

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS

PAGE (2) GPO 934-110 Form OSHA-20 Rev. May 72

PAGE (1) (Continued on reverse side) Form OSHA-20

Fig. 3.257 Material safety data sheet

procedure. Product sludge concentrations and bulk adhesion, a product change-over, leak detection requirements, coating repair or a new coating installation can be the itinerary of a required service.

Due to today's accepted UHP coating removal criterion a qualified service provider can encounter a job scenario in that customer requests cleaning a vessel first for inspection and repair, followed by a coating removal in conjunction with an coating installation procedure.

Regardless, cleaning comes first requiring a set of safety practices and requirements tightly controlled by plant maintenance, state and federal regulations. When applying high-pressure water or emulsifiers the visibility in tank interiors

(a)

CITY OF SPOKANE
WASTE WATER TREATMENT

JOB DESCRIPTION

Remove ash, sewage, and dirt from two clarifiers.

EQUIPMENT

One Hydroblast Pump
400 feet ½" Hydroblast Hose
400 feet 4" Discharge Hose
200 feet 1½" Fire Hose
two ½x8' SS #80 Lances
Four Slurrifying nozzles
Two "Flyte" 4" submersible pumps
One Generator to drive submersibles

JOB PROCEEDURE

After draining clarifier of top water, technicians enter clarifier to manually slurrify ash sewage material. Lances are operated at 4000 PSI, using a"T" from hydroblast pump.

Initially, technicians slurrify material from outside edge working toward center of clarifier. As material runs toward center of clarifier,the submersible pump is activated. The pump is positioned using a chain hoist rigged to catwalk directly over center of clarifier. The slurrified material is pumped via 4" hose to waiting dump trucks.

As soon as ¼ of clarifier is slurrified and pumped. The technicians slurrify center area and pump out material. Then the rest of the material is slurrified and, following slope clarifier, runs toward the center where it is pumped away to waiting trucks.

(b)

CITY OF SPOKANE
Page 2

Due to nature of ash sewage mixture, care must be exercised to achieve proper water to material ratio. Otherwise, submersible pump will clog. Proper viscosity is achieved when loading. Time to load 20 yard dump truck is approximately 12 minutes. Four dump trucks are kept moving continously on a 12 hour basis. It is essential to keep viscosity at proper ratios to avoid clogging of pump, long loading times, and too much water in mixture.

TIME REQUIRED

Seven 12 hour shifts per clarifier to remove approximately 400 - twenty yard dump truck loads per clarifier.

SAFETY CONSIDERATIONS

Full watertight protective clothing including head and eye covering for all personnel in tanks.

MANPOWER

one operator
four technicians

PLANT CONTACTS

John Snell John King

Fig. 3.258 **a**, **b** Job description, wastewater treatment facility

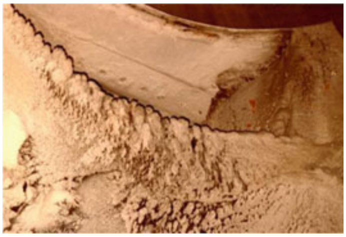


Fig. 3.259 Smoke stack intake, before

and within some containment systems on tank exteriors can be very limited. Explosion proof lighting should illuminate an interior vessel totally and not be limited to the blast or product removal area. Limited visibility will not only decrease the ability to produce quality work but also inspections. Needless to say, that with good visibility accident likelihood is also reduced.

Once bulk product has been drained and removed the hydro-vac system supported by emulsifying–slurrifying and/or water–detergent jetting techniques will quickly move liquefied waste and sediment to a vacuum boot situated in the vessel's lowest point. Methodically utilizing squeegees behind a jetting operator permits the visual verification of required cleanliness for the final wash down procedure. Exterior spill prevention within a tank cleaning procedure (Fig. 3.264) is a requirement of utmost importance as is inadvertent litter and contaminant cleanup within empty tanks secondary containment area where equipment storage and its operation is most often performed. This type of pressure washing and hydro-blast application is in itself quite straight forward.

Fig. 3.260 Hydro-blasting intake

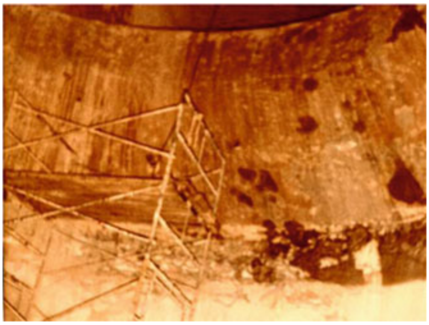


Fig. 3.261 Smoke stack intake, after

Fig. 3.262 Accumulated bulk debris

Most often a performance reduction or limitation arises due to the complexity of a confined space entry procedure. Safely managing flammable, explosive and toxic atmospheres, including industries physical hazards encountered, always supersede a possible application curriculum as to its efficiency and effectiveness.

Fig. 3.263 Fuel–oil tank facility

Fig. 3.264 Typical commercial tank farm

An interior toxicity problem or fire and explosion prevention requirement and its curriculum can also engage the exterior concerns due to the proximity of manufacturing hardware providing a possible hazardous emission potential. The wearing of air supplied respiratory protection of continuous flow or demand flow, the bulk of an entry and egress system, somewhat physical restrained by safety and personal protective gear, maintaining a clean face shield while jetting, etc. will slow an otherwise simple cleaning procedure considerably especially when the characteristic of the space is poorly illuminated and its ventilation is inadequate diminishing visual surface orientation by steam or misting.

When a cleaning procedure is followed by an interior coating or fiberglass tank lining removal application the following necessary drying and dehumidification procedure may also require the utilization of respirator gear. As a coating is removed and simultaneously a new coating is installed within the drying and dehumidification process the coating will admit its volatile constituents to the interior environment.

Cleaning maritime vessels, fresh-water and potable-water tanks, feed water tanks, fuel oil storage and stowage tanks, diesel fuel oil tank, JP-4-JP-5 fuel tanks, barge holding tanks, etc. are tank-cleaning applications most often performed by shipyards and their subcontractors and are of general nature.

Taxing are the confined spaces below engine, generator and pump rooms which includes voids below the compressor in auxiliary machine rooms to shaft alley and sewage plant, including the steering gear room bilge voids. The free movement of a lance assembly within these voids can be problematic and is most often frustrating due to operator's physical confinement. Providing a safe atmosphere, and correctly illuminating voids to facilitate a systematic cleaning procedure and

Fig. 3.265 Butterworth, centrifugal pump feed, 3D nozzle design (ca. 1926), still in service today

having available a variety of lance extensions fitted with quick couplers is of the utmost importance. Fan nozzle attachments of varying degree, including a pipe cleaning nozzle assembly with guided straight and 45° light weight flex lance retainer tubes of various lengths are also essential. Within this application criterion a contractor's relationship with his equipment supplier or suppliers providing this tooling flexibility is of great consequence. This job criterion may also require lance and nozzle manipulation by two operators where a foot valve and trigger-gun operation may be utilized in tandem or individually within a jetting procedure.

As a cleaning procedure commences from ship-hull's elevated area downward through the bilge voids, run-off water and debris must be simultaneously removed utilizing the hydro-vac system. This necessary application procedure will guide the removal of deck plates and gratings from each space which is best decided upon by including the jetting personnel's experienced opinions. If there are sound dampening tiles installed in bilge areas their protection must be guaranteed. Grates and plates must be tagged as to their correct location and put on hold for reinstallation. Temporary decking in walk and work areas is installed in a manner that injury to vessels personnel resulting from cleaning procedures cannot occur. Mask and cover with moisture repellent material (plastic sheeting) all controllers, electrical components and sensitive machinery. After protecting equipment from possible water intrusion, affix signage to all areas where jetting procedures may produce danger to the unwary. Blank-off all open ends of piping, check and stop oil leaks from machinery into bilge area. The UHP application to remove existing coatings can be supported by a citric acid surface treatment to remove oil–grease remnants and iron oxide (rust). This also requires the correct flushing and passivation of bare steel in its surface drying procedure to prepare for a successful coating application. Prior to this application clean all passageways and ladders, floor boards, etc. of possible oil–grease or overspray preventing re-contamination of cleaned areas. The citric acid treatment is not successful on undetected sound remaining epoxy coatings. In these areas loss of adhesion and delaminating of a new coating is imminent after a citric acid treatment. Regardless, this chemical process is only applicable to surface ships, where chemical surface preparation is authorized. The term bilges describes the portion of an interior hull shell plating, internal support

structures, bilge wells and sumps, tank top plating, and boundary bulkhead from keel up to top of existing bilge redline. Included are foundations, longitudinal beams, vertical keel, keel brackets, rider plates, transverse frames, stiffeners, and miscellaneous support structures.

Old-school will also identify to tank-cleaning as "*butterworthing*" (Fig. 3.265).

GEAR-LIST AUTHORIZATION

Tanks, vessels-autoclaves, precipitators, container cleaning, volatile effluent removal

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: State:	P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			

Hydro-blast equipment: Pressure washing equipment: hot-cold Hydro-vac equipment: Centrifugal sludge separator: Vacuum container: Water filtration-recycling equipment:			Monitor environment: Draeger air-gas sampling: Draeger personal gas monitor: Heat stress exposure monitor: Radiation survey meter: Emergency planning and rescue review: Emergency shower, eyewash location: Lockout/takeout: Equipment locks: Pipes: Flange cover installation: Valves: Other:		
Equipment: T-dual cleaning head: Turbo nozzle: Coating removal equipment: Hot-cold water: High-pressure gun: Foot valve: Flex-lances: Tube guide: Rigid-lances: 3-Pronged lance manifold: 2-Pronged lance manifold: Other:	Vacuum support:		Tank location: Vessel entry permit: Self-contained breathing apparatus: Egress equipment: Full face positive pressure respirator: Air compressor: Air purifying equipment: Confined space ventilation equipment: 12-Volt explosion-proof lighting: Rust-inhibitors, metering equipment: Other:		MSDS:

Product hardness, adhesion, viscosity:	*Specify:*	*Product volume:*
Fouling characteristics:	*Specify:*	
Physical surroundings, safety procedures:	*Specify:*	
Describe application and work procedure:		Others:
Itemize further equipment, safety gear, expendables, labor and equipment times, etc.		

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail	Engineering: Tel: e-mail	Maintenance: Tel: e-mail	Safety: Tel: e-mail
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			
Storage tank, vessel, bilge: Other: Contaminants to be removed: oil, grease, soluble salts, sharp edges and weld spatter, coatings, abrasive, etc: Volatile or chemical substances to be removed: Volume: Dry: Wet: Desiccated: Identify: MSDS:	PPM	Dehumidification equipment: Desiccant: Cfm: Necessary relative humidity: 5%, 10%, 15%, 20% Ambient temperature: Necessary interior temperature:	
Hydro-blast equipment: Water filtration-recycling equipment:		Equipment: Three-way winch system top entrance: Full body harness: Specify heavy-duty pvc-nylon-polyethylene or disposable coveralls: Other: Expendables:	
Product encountered:			
Hazardous material:	MSDS:	Specify:	
Describe application and work procedure: Testing for: PPM: Carbon monoxide: Hydrogen sulfide: Sulfur dioxide: Nitrogen dioxide: Chlorine: Itemize equipment, safety gear, expendables, etc.:			

3.23 Hydro-abrasive Blasting, Steel Cutting-Demolition Applications, Underwater Hydro-blasting and Dredging

Prior to establishing WOMAs, subsidiary in Linden, New Jersey, the company demonstrated its tool capacity to clean pipes, sewers, tanks, and perform the runway rubber-removal application by their "*high pressure water as a tool*"

Fig. 3.266 1967 third generation abrasive injector

Fig. 3.267 Hydro-abrasive blasting buoys

perception (1967). This included paint-coating deletion in aircraft parking areas, turbine blade cleaning with aluminum oxide and corrosion-rust removal all by hydro-abrasive blast techniques introducing the third-generation blast equipment.

An International harvester truck-chassis utilizing WOMAs equipment, chemical-abrasive-water and sludge tank (hydro-vac system) and included the 150–152 horsepower, PTO powered reciprocating pump with four standard interchangeable plunger set configurations, accommodating the required application range demonstrated in commercial, industrial and marine environments. Supported also by two hydraulically operated hose reels for sewer cleaning and high-pressure hose storage, the application range was at this time exceptional and included trigger gun and/or foot valve operated rigid and flex lance operations. Demonstrating and introducing to Newark, New Jersey's airport facility, the capacity of runway rubber and coating removal (Fig. 3.266), or cleaning pulp paper industries suction rolls and/or removing kiln clinker buildup in cement plants proved quite newsworthy within these industries. The hydro-vac dredging, pipe and sewer cleaning application and hydro-abrasive water jetting varieties for commercial and industrial maintenance yards was a technically leading and extraordinary demo experience for customers and WOMA alike. The trip started in Newark, New Jersey and followed the coast down to the Miami airport to wash its airports-building facade, to the Gulf Coast demonstrating hydro-blast jetting technologies on condensers which included the introduction to the Navy and Coast Guard the boiler tube cleaning and removal of barnacle growth and corrosion on their ship hulls and buoys (Figs. 3.267, 3.268), etc. This demo trip also facilitated the first contract

Fig. 3.268 Coating-corrosion removal, ship-hull

Fig. 3.269 Concrete roughening

work by hydro-blasting competing directly with chemical and mechanical cleaning operations. Results justified the decision to commence with the establishment of WOMA Corp. (USA 1968).

The often skeptic observer was not sure at all that hydro-abrasive blasting had a future in the coating removal and coating–painting environment. Today, after performing thousands of corrosion and coating deletion applications on all imaginable metallic surfaces and the following experience of successful coating installations and their proven longevity, the skepticism has dwindled. Especially since the manual UHP-AB and automated UHP coating removal applications on surfaces with existing anchor profile moved into the industrial mainstream criteria. Equipment varieties and their varying performance standards, considering horsepower input, functionality of accessories (abrasive hopper and supply), the multitude of abrasives and possible application criterion can be quite confusing. The hydro-abrasive jetting aspect strongly depends on operators and technicians experience level which is a cumulative result from past job performances and their preferably successful established histories. Admixing within a hydro-injector's chamber, the most advantageous conventional or alternative abrasive media to polish, clean or remove oxidization, accidental product accumulations, paint and/or a coatings (Fig. 3.269) including fungus growth on surfaces providing nutrition etc. requires a precise differentiation of substrate conditions.

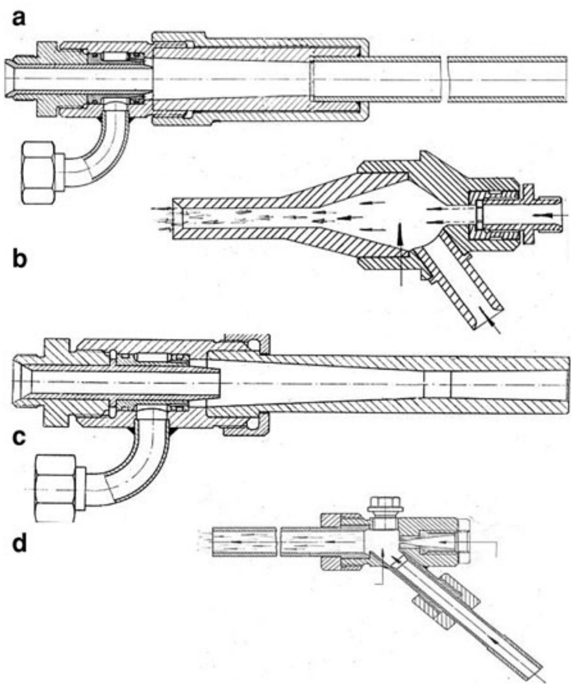


Fig. 3.270 **a** Extended life, vacu-boron chamber; **b** 3000 psi, 5 gpm abrasive-chem. injector; **c** industrial–commercial extended life; **d** first-generation 1966 concrete-steel cutting head

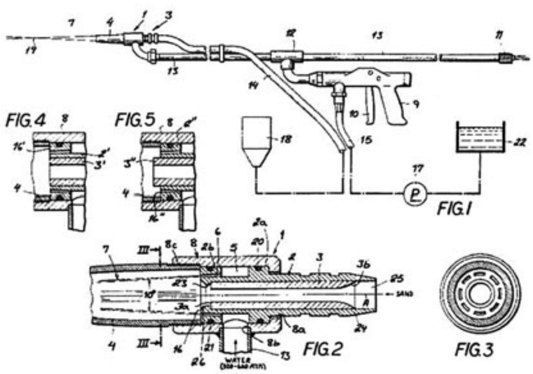
Equipment design variations (Fig. 3.270) nozzle-injector technology and psi–gpm–horsepower input are great influences to the performance criterion which involves not only a surface treated and square footage-time performance, but also decisive cost variables for abrasive products.

A job classification and bidding procedure depends on the correct identification and classification of the desired surface appearance. This is achieved by cleaning; polishing or roughening attained by high velocity water admixed with various abrasives (anchor profile).

Polishing and avoiding a surface profile or to determine a profile categorization for a necessary surface appearance, the required surface treatment, addressed or included into a job-bid procedure must be a steadfast foregone conclusion offered to the contractor by his prospective customer.

Besides classifying substrate material and structural configuration, its deterioration, adhering corrosion or product to be removed etc., the existing performance knowledge of conventional and alternative abrasives can by retrieved from manufacturer and their stocking distributors, or trade associations as SSPC and NACE providing visual reference publications for the UHP, hydro-abrasive and water jetting orientation which includes the wet abrasive blast criteria offering similar surface appearances. Wet abrasive blasting differentiates from hydro-abrasive blasting mainly in a harder abrasive impact. Hydro-abrasive blast water can, if so desired, provide a cushioning effect, facilitating a gentle surface preparation which

Fig. 3.271 Patent draft, forth generation recoil-neutral, injector-gun assembly, and its abrasives supply equipment



includes polishing sensitive surfaces avoiding abrasions and environmental contamination.

Every encountered substrate will lead to product identification whether it is plastic, fiberglass, wood, glass, brick, granite, concrete, bronze, coated aluminum and structural steel or exotic metals, such as found on statuary, industrial and architectural structures and/or specialty equipment, etc. (Fig. 3.271).

Abrasives type and their classification are chosen by identifying substrates surface tensile strength and vulnerability to interface structure when an application calls for contaminant and existing oxidation removal; simultaneously achieving a polishing effect (various grades), coating and/or corrosion removal with or without interface profiling, removal of deteriorated and friable concrete, or structuring wood, brick or stucco surfaces. When an experienced opinion is not available as to choosing a correct abrasive is it best to consider the Mohs scale of mineral hardness. This facilitates a significant baseline for inexperienced and/or novice pressure washing and hydro-technicians, especially when considering all variables encountered matching a ultra soft or otherwise abrasive blast medium to the available equipment identity.

Besides polishing a surface the choice of an adequate abrasive may be guided by a surface environment, the corrosion protection, and the coating application criterion. For coating applications an abrasive must be clean, oil–fat free, pH neutral and free of salt residual. Removing coatings in a confined high-tech area, the abrasive can be biodegradable and water soluble adding no dust or product contamination especially when a water recovery–filtration–recycling equipment is applied. In agricultural environments, an agricultural byproduct may be applied as an abrasive, avoiding all further contamination to its environment and as for building restoration and/or architectural components one can apply Portland cement powder, sodium bicarbonate, plastic media, pecan or walnut shells, including corn cob granules, etc.

Abrasives:

Silicon carbide	a man-made mineral, hard, angular sharp and free cutting abrasive supplied in grain

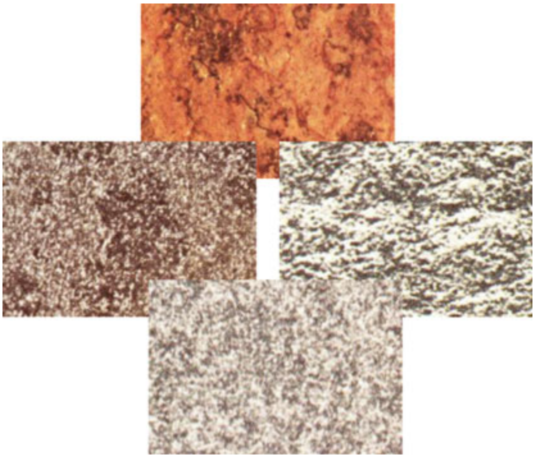


Fig. 3.272 Various steel plate profiles

	and powder form, 8-1200 grit utilized for lapping, polishing and cutting…MOH: 9.5–10.0
Aluminum oxide	a tough, iron free abrasive for cleaning hard materials, turbine blades, removing metal flash-lapping, metal and stone cutting applications, 4-1200 grit,…MOH: 9.0
Sintered bauxite	alternative to aluminum oxide…MOH: 9.0
Calcined bauxite	inexpensive alternative to aluminum oxide…MOH: 9.0
Ceramic beads	spherical beads, 60–325 mesh, produces a satin finish on stainless steel and nonferrous metals, harder than glass…MOH: 7.5–8.5
Garnet	8-1200 grit, angular to sub angular for paint, coating, rust and scale removal, varies anchor profiling on steel and concrete surface roughening…MOH: 6.5–7.5
Silica sand	4–270 mesh, sub-round for efficient industrial hydro-abrasive blast applications, which includes bridges, tanks, ship hulls, etc…MOH: 7.0
Glass beads	precision made glass sphere, 20–200 plus mesh, sub-round, deburring, cleaning, honing, polishing, and finishing…MOH: 5.5–6.0
Glass grit	18–200 mesh, angular sharp edges, lighter than glass beads, produce a very bright surface when preparing aluminum, brass, copper and stainless steel…MOH: 5.0–6.0

Fig. 3.273 a, b Cast iron after hydro-abrasive blasting

Melamine	cleaning soft metals and composite…MOH: 3.0–4.0
Plastic media	10–200 mesh sub round to angular, cleaning soft metals and composite, metal fabric screens, etc…MOH: 3.0–4.0
Corn cob granules	blocky, 10–100 mesh, polishing surfaces as aluminum and fiberglass substrate, graffiti, paint and contaminants removal on wood and architectural components, smoke damage deletion, deburring, oxidation and corrosion-rust removal…MOH: 2.5–4.0
Nut shells	angular multifaceted abrasive, 6–300 mesh, for cleaning and mold removal on soft wood or similar materials, cleaning aluminum, plastic, stucco, etc…MOH: 2.5–4.0
Sawdust	clean and polish soft surfaces or remove sheen
Magnesium sulfate	(Kieserite) soluble, pool tile cleaning, calcium deposit removal on glazed tile…MOH: 2.5
Baking soda (sodium bicarbonate)	60–180 mesh, crystalline shape, cleaning, paint removal, mold remediation, polishing surfaces, hardness in the talc and gypsum range…MOH: 2.5
Cement powder	

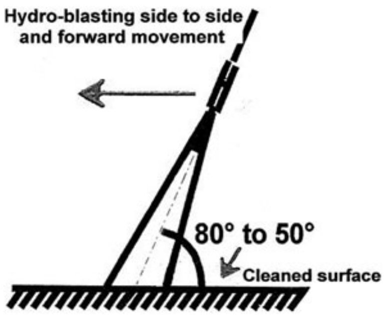


Fig. 3.274 Water jet angle

(Portland) ideal to remove sheen or gloss on polished surfaces, creating a smooth dull surface, patina removal…MOH: 2.0–4.0

Blast abrasive sizing is described in microns or range of microns (20/30, 40/60, etc.) and/or mesh size. Its shapes described as sharp edge, angular, blocky and round greatly influencing buffing-polishing, cleaning, product removal, surface roughening and anchor profiling performances.

With a few exceptions, corrosion-rust removal application methods on steel surfaces must always include their technical application aspect and the follow-up preservation (Fig. 3.272) or coating criterion. The novice best identifies this job aspect first. It does not matter much what quality of work has been performed if preservation procedures, which are designed to be compatible with paint-coatings applied, their application timing, drying and humidity controls on open steel or iron surfaces are neglected (Fig. 3.273).

Humidity controls are especially important in a confined space, such as for instance within the interior of storage tanks for liquids, interior high humidity–acidic production facilities as in paper-pulp industries, food production environments and the interior of ship-hulls, etc.

As to the question, how much abrasive is required? solely depends on the application encountered and its surface area. Metal pitting depth and mill scale remnants, coating interface depth and adhesion, abrasives specific gravity, its sharpness and high bulk density, injector's design efficiency, simultaneous two or more injector operation, etc. are all mitigating factors. Performing a test patch procedure in all areas where a structural or physical change can occur, timing and utilizing between 1 and 5 lb/ft^2 blast abrasive can best determine the ft^2 production quantity per 40 or 50 lb bag possibly recognizing 40 to 200 ft^2 per bag and so forth. The desired anchor profile and its peak count can be established by utilizing a profile-meter which incorporates a stylus to trace the distance between created peaks. The traces should be disbursed over the test area as identified and described by equipment manufacturer (in all directions). ASTM D-4417 and D-7127 for

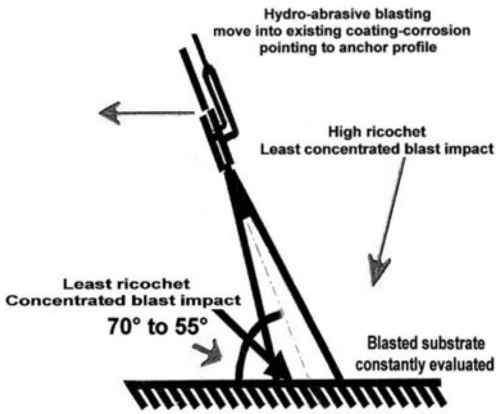


Fig. 3.275 Hydro-abrasive blast angle

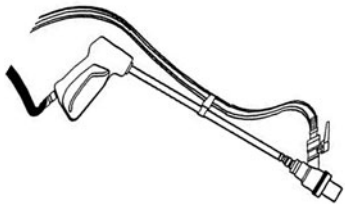


Fig. 3.276 Injector angle, glancing over steel or any surface will alter an existing profile

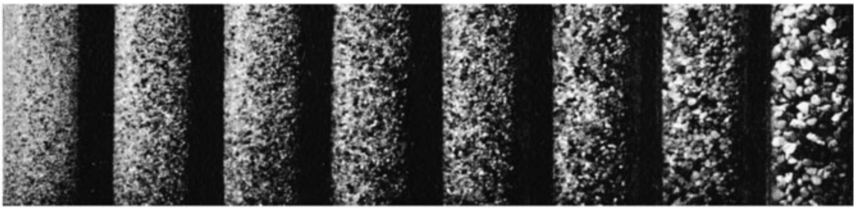
standard test methods for field measurement of a surface profile on steel are established guidelines considered when verifying a performance criterion.

Timing a test area, one must include all support activities, which should never interfere with a production blast schedule. This is very important on public construction sites or construction sites where a variety of trades are simultaneously performed involving scaffold safety, cleanup and water recovery and/or recycling procedures.

When choosing a new coating system, the specification for its installation identifies the required surface profile as to depth and highest peak count possible while facilitating a complete surface wetting characteristic for the coating in question. The peak count and profile height is created by abrasives impact velocity, size and density (Fig. 3.272). High-pressure water velocity and mass, abrasives surface shape, specific weight the higher the deeper its penetration, creating a wider distance between peaks. Controlling the profile height is therefore a function of abrasive size-sharpness, hardness and density combined with its impact velocity (psi).

Starting with the lowest adjustable psi configuration providing an acceptable desired anchor profile, the upward pressure adjustment to the most effective or efficient profiling or coating removal time prevents the utilization of pointless excess power input. Also an abrasive particle, which remains intact upon surface impact, will convey more energy to the surface interface. The type of abrasives employed within the hydro-abrasive blast method is less critical with one

a



An alternative identification for inert, non-toxic and odorless abrasives is:

b

SPECIFICATIONS

Number Designation	Physical Description	Size Range	Anchor Pattern	Partical Count
1	Extra Course	(8-20)	4 mil	100,000/lb.
2	Course	(10-30)	3 mil	300,000/lb.
3	Medium	(20-40)	2 mil	3,000,000/lb.
4	Fine	(40-80)	1mil	30,000,000/lb.
5	Extra Fine	(70-170)	1/2 mil	300,000,000/lb.
6	Flower	(170-Finer)	Frost	1,000,000,000/lb.

#1 (8-20) #2(10-30) #3 (20-40) #4 (40-80) #5 (70-170)

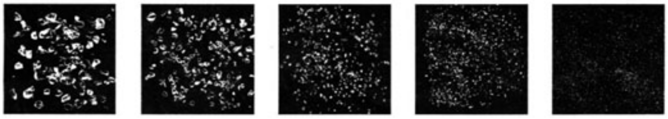


Fig. 3.277 **a**, **b** Abrasive specifications

exception. Within impact and breakup, agricultural abrasives tend to deposit fat–oil residual upon treated surfaces reducing the possibility of immediate coating.

Available hydro-abrasive injector-nozzles operate between 2,500 and 6,500 psi. Anything above this performance is pointless. The destruction and/or friability of abrasive blast material diminishes energy transfer performance which can escalate due to loss of operator efficiency and comfort level induced by excessive recoil force and abrasive jet ricochet (excessive pressure). The applied hydro-abrasive jet angle or degree does also influence the substrates peak count and profile (Figs. 3.274, 3.275). A glancing angle will introduce a lower profile (Fig. 3.276). Most effective is a 60° to 70° angle, with an abrasive barrel stand-off distance at its most efficient cone spread to the substrate interface which should always be the guiding aspect. Near white metal conditions are achieved quickly outperforming air abrasive blast-techniques in their time intensities and material cost criterion and most importantly in an environmentally friendly and correct application procedure, minimizing the hazard burden throughout most application environments. The physical aspect in guiding a hydro-abrasive nozzle over its work piece, structure or flat surface is a skill specifically identifying abrasive blast operations. The pressure washing and hydro-blast jetting technique requires the sideways and forward movement with varying angle of 80° to 50° and nozzle standoff distances adjusted to the adhesion and bulk-volume removal dynamics which includes the avoidance

Fig. 3.278 **a** Concrete cleaning; **b**, **c** stucco polishing; **d** pumps and abrasive pickup equipment; **e** abrasive pick-up, injector

or creation of ghosting effects in porous substrate. The quality of hydro-abrasive blasting relies on the constant visual evaluation of blasted surface to obtain a uniform surface structure. A non-uniform surface and peak count can also be the result of particle size variations with varying bulk batch, or from bag-to-bag.

Vibration-handling tends to separate fines from coarser abrasive during a bulk storage and/or packaging procedure, resulting in one bag or batch having a higher percentage of fines than the previous lot.

During loading, transportation and unloading of bulk material a breakdown and separation of particles can also occur. Excessive loading or unloading velocities are most often responsible for this separation. Often overlooked and responsible are conditions within blast pots, especially large pots. As abrasive flows to the bottom control valve, fines tend to build up within the center of a load and along sidewalls. This can result in sputtering flow introduced by fines which often break loose all at once. Inadvertently, during this time blast productivity decreases and profile is altered. The best preventive measure starts with gentle product treatment and control of product quality while loading abrasives manually or mechanically for approx. 20 min uninterrupted hydro-abrasive blast operations. This time frame also controls excessive build-up of humidity. Surfaces produced from differentiating abrasives will fluctuate both in peak count and height and promotes unreliable production rates. The blast technique controlling the abrasive jet nozzle is responsible for surface uniformity and will very to a certain degree with abrasive type and its job purpose as to its specification. A 55° to 70° hydro-abrasive jet angle is most desirable and will provide with a systematic slow sweeping motion a uniform blast surface. The nozzle standoff distance is 16″ to 26″ which will vary according to abrasives selected. The hydro-abrasive blast method permits the utilization of non recyclable cost effective abrasives such as sand, aggregate, slag (Fig. 3.277), etc.

Mostly underrated are the positive results attainable on deteriorated grout, stucco, plaster, and weathered concrete murals. The degree of cleaning is determined by incorporating to a high-velocity water jet an ultra soft medium which cannot under any circumstance result in adding a peak count or deformation to any surface profile. Such an obvious surface sensitivity demands a gentle polishing effect (Fig. 3.278c) to the substrates surface manipulating a range of surface contaminants. The direct advantage in the removal process is preventing scratching or damage by deformation often encountered with mechanical or

Fig. 3.279 Today's injector design

Fig. 3.280 Tank cutting-demolition applications

physical methods. A qualified hydro-technician will choose possible media variety solely by the correct classification of a substrate encountered. Analyzing substrates surface and tensile strength, coefficient of adhesion and depth of interface contamination can also acquire a multifaceted application criteria involving water dwell time, chemistry and a mild surface manipulation in polishing various detailed work.

Stucco, concrete restoration, and/or repair procedures benefit when hydro-abrasive blast techniques are combined with various soft blast-media.

Preparing a damaged concrete surface utilizing 3,000 psi at 5 gpm and applying a following hydro-abrasive treatment at the identical performance criteria (coarse abrasive) to remove all remaining salts, efflorescence, laitance and other foreign matter which adversely affects a concrete structure can often produce a job classification otherwise slated for destruction or major structural restoration. Due to its porosity and aggregate count, the concrete interface structure can be cleaned, truly neutralized and roughened to a degree that facilitates a total product bond similar to its original strength. For restoration purposes the hydro-abrasive method is ideal due to its equipment mobility. Most often abrasive product delivery does not require compressed air to energize a hopper. Most injectors (Fig. 3.279) create ample vacuum to deliver abrasives conveniently placed within jobsite vicinity. This can be of importance when

Fig. 3.281 1967 the first commercially available concrete cutting head

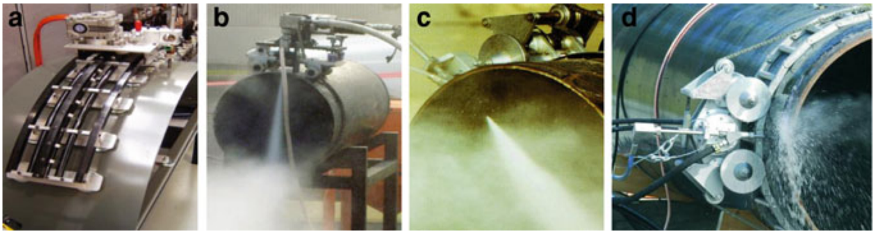


Fig. 3.282 **a**, **b**, **c**, **d** Steel–concrete cutting equipment. **a** Magnetic-belt fixture, **b** chain drive cutting unit, **c** chain-belt drive, jet exit, **d** chain-belt drive, injector-nozzle assembly

Fig. 3.283 Underwater hp-gun and jet safety sleeve

Fig. 3.284 Marine growth removal

Fig. 3.285 Underwater abrasive delivery system

GEAR - LIST AUTHORIZATION

Hydro-abrasive blasting, steel cutting-demolition, underwater hydro-blasting and dredging

Customer & Company: Web site: e-mail: hp-Injector		Date: Address: City: State:	Job Nr.: P.O. Box: Zip Code:
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:

Job Description:

Job Location: Job Site Risk Assessment: Specify: ©

Job Review Performed by:

Hydro-abrasive blasting: Steel cutting demolition: Underwater hydro-blasting: Underwater dredging: Other:			Abrasive type: MOH: Abrasive size: Nr.: Abrasive lbs: Psi: Gpm: Substrate: Peak count: Profile height: Roughness: Chemicals: *Specify:* *MSDS:* Other:		
Equipment: Hydro-vac equipment: Hydro-vac vacuum-hose: Yards: Hydro-abrasive injector: Abrasive hose: Abrasive hopper: 2-Pronged abrasive manifold: High-pressure balanced trigger gun: Underwater: Dive equipment: High-pressure trigger gun: Foot valve: Hydro-blast equipment: UHP equipment: Other:			Vessel entry permit: Nozzles: Remote-automated abrasive equipment: T-dual abrasive cleaning head: Turbo nozzle heads: Rotary jet: Air compressor: Rust-inhibitors, metering equipment: Other: Divers:		

Product hardness, adhesion, viscosity: *Specify:*

Fouling characteristics: *Specify:*

Physical surroundings, safety procedures: *Specify:* Other:

Describe application and work procedure:

Itemize further equipment, safety gear, expendables, labor and equipment times, etc.

difficult locations must be reached or long distances between pump equipment and blast area must be breached.

After the removal of frost damage, abrasions and/or concrete carbonization, a repeated aggregate discovery as to its overall classification and condition is of importance. Job experience has proven that a distinguishing and suitable restoration procedure can most often be streamlined and enhanced due to overall favorable conditions now identifiable. Generally, substantial and unexpected savings are realized within restoration procedures. Equipment is available to gauge surface roughness, tensile strength, concrete humidity and pH, within a remaining interface structure which is always important facilitating performance warranties for new product installations.

Concrete surface preparation reference, ASTM D-4258, standard practice for cleaning concrete, ASTM D-4259, standard practice for abrading concrete and ASTM D-4260, standard practice for etching concrete are guidelines established for mechanical and/or chemical application methods. Today the available hydro-abrasive, hydro-blasting and UHP application curriculum has through the years developed into an application criterion most often superior to this preparation reference.

Pipeline and steel cutting applications or demolition where fractured tanks or volatile nuclear-refinery-chemical vessels (Fig. 3.280) are in need of dismantling, structural change or repair is a service specialty most often performed by well-regarded identities versed in providing hydro-blasting and UHP application services in hazardous environments.

These contractors almost always maintain a close relationship with equipment manufacturers, which can provide tool flexibility and know-how for specific application requirements.

High-pressure water jets admixed with abrasives, have absolutely no limitation in their cutting potential. First employed in 1966 the concrete cutting heads (Fig. 3.281) responsible for dismantling bridge pylons and bunker walls by cutting through concrete and rebar structure without delay brought on this awareness. The idea that high-pressure water will not effectively cut steel was quickly rebuffed within this jet cutting procedure. The knowledge that a water stream admixed with an abrasive will not compromise its cutting time throughout an heavily reinforced concrete rebar structure pointed to the developments which today far surpass the experimental stage (Fig. 3.282). The metal and stone available concrete-cutting head cutting input performance range is within 0.05–1.2 gpm at 45–60,000 psi, resulting in a nozzle-abrasive jet size from 0.030″ to 0.80″ø. Generally garnet is utilized as an abrasive from 0.5 to 1.8 lbs/min.

Underwater hydro-blasting or abrasive cleaning is an application also developed in the early 1960 (Figs. 3.283, 3.284, 3.285). The main motivation for its technology development was the possibility of removing marine growth on ship hulls reducing the hydrodynamic friction resulting in enhanced propulsion efficiency. Today ship hulls are serviced regularly, preventing bio fouling buildup, extending the effective life of an anti-fouling coating and sustaining the anti-corrosive coating system for longer dry dock intervals. Also hydro-blasting is a

maintenance identity most often utilized in shipyards, and/or offshore facilities servicing oil platforms, piers and water dam installations which includes underwater corrosion control (Fig. 3.286) and coating applications, intake wellhead cleaning, zebra mussel, algae-marine growth removal, lock and dam work, etc. Cleaning pressures range from 10 to 14,000 psi utilizing 22 gpm plus. The underwater application can only be as good as the training provided to divers operating high-pressure water equipment. Underwater maintenance repair contractors operate on steel structures from 30,000 to 36,000 psi, for aluminum structures 18,000–20,000 psi. The standard surface profiles by underwater hydroblasting or UHP technology ranges from 40 to 100 μm and produces a NACE, No. 5, SSPC SP 12 surface appearance. The IMCA international marine contractors association (www.imca.com) can greatly provide support as to information on qualifying and testing for divers.

Underwater dredging and/or clearing pond bottoms or inspecting and removing silt from community water towers can also be an application only managed by a licensed marine or industrial diver. The hydro-vac system and application criterion in core application chapter #7 is fully employable.

3.24 Wash Water Control, Recovery, Filtration, Recycling, Wastewater Reclamation Technology, Evaporation, Hazardous Materials Cleanup, Chemical Rinse Aids

How to catch onsite wash water is probably a question looked upon with distaste by previous hydro-blast and pressure-washing generations. Today, this added necessary feature, or better attribute, does provide a great business opportunity for savvy and technically flexible hydro-technicians. Realizing that a correct environmental cleaning technology not only supports the conventional application variety and business opportunities into the hazardous spill, lead-coating abatement and sanitary emergency response field and/or cleaning endeavors in confined moisture sensitive areas, a novice inquiry often fails to notice a vital technical application divide. The water pollution control permit requirement identifies and considers spent wash water as “wastewater”. Therefore a mobile power wash business, cleaning gas station and fast-food restaurant drive thru’s, vehicles, construction equipment, interior or exterior building-structures, etc. discharging spent water which includes unidentified turbid water directly into a storm sewer collection system without a pretreatment permit is considered a violation.

Wash water control, its recovery (Fig. 3.287), and filtration for closed loop recycling is one facet which must be separated from available water reclamation technologies which is to remove wash water to gain a concentrate/remnant. These

Fig. 3.287 Adjustable vacuum shoe, bladder containment

Fig. 3.288 Utilizing concrete berm and water bladder

Fig. 3.289 Secondary drain and manhole containment bladder

accumulations often result in a hazardous material cleanup and its transportation classification.

When cleaning on exterior non-permeable hard sealed surfaces, where oil and grease loads are prevalent, the wash water control achieving a closed loop application is simple. Utilizing a natural gravity flow on non permeable grounds and strategically placing water dikes to guide grease and oil laden water to a vacuum shoe (Fig. 3.288) is basic. This type of wash water control is quick and competitive. Guarding against escaping liquid to a storm drain or rain gutter, water filled bladders can be situated into lowest point incorporating a secondary vacuum or pump station (Fig. 3.289) (emergency). Whatever method is utilized the filtration and recycling equipment is based on the effectiveness of silt and oil water separation, and polishing filters to below 5 μm to guarantee pump fluid-end and accessories longevity.

This gravity flow (Fig. 3.290) method can also be utilized in parking garage structures where their drainage system is isolated from storm drain or sanitary sewer access. Often, simply installing a blind flange which incorporates a vacuum

Fig. 3.290 Uphill 200′ wastewater recovery

Fig. 3.291 Wash water interception

access providing direct feed to the oil water separator eliminates the trailer movement throughout a unit. The high-pressure hose assembly is often provided through the center of a parking structure. Cleaning from top down the high-pressure hose is disconnected and adjusted to the lower floor and its total width. The garage drainage system will deliver oil–grease laden effluent directly to the vacuum–filtration side of the equipment strategically placed to the nearest pipe access before entering the storm drain-sewer system. Cleaning surface areas close to or within a storm water conveyance system is regulated by their municipality. Their established “best management practices” for mobile pressure washing contractors (BMPs) can include guidelines to minimize improper or accidental discharge into the storm drain system. These areas can be described as sidewalks, gas station surfaces, bank-restaurant drive thru’s, houses or building-façades joined to sidewalks or asphalt incorporating a storm sewer system.

Due to a diverse natural runoff and varying grades the operator must plan on how the wastewater will be collected. Vacuum booms of various designs (Fig. 3.291) are flexible dams 4″–6″ in height arranged to intercept the wash water flow. Connected to trailers vacuum and filtration equipment they feature gaps in

Fig. 3.292 Various drive on containment. **a** Smooth surface containment mat; **b** heavy-duty drive on rubber bridge; **c** heavy-duty underlay containment; **d** wastewater containment basin

increments to the ground surface, sucking up impounded wastewater by accelerating vacuum-air velocity into the inner tube of boom. Portable water or sand packed plastic dams-booms, light or heavy duty wash down containment mats (Fig. 3.292), mobile metal pits incorporating a water filtration recycling capacity, tarps and most importantly, rotary surface cleaning equipment incorporating a vacuum shroud to immediately remove all wash water are tools employed to avoid an uncontrolled discharge onto permeable ground, sidewalks, street gutter and storm drains.

A mobile recovery system which removes effluent from its containment area or a vacuum shroud is often energized by a primary vacuum system. A vacuum's energy may also be utilized to provide a centrifugal separation of all non-buoyant heavy solids (Fig. 3.293), as dirt and sand constituents accumulating in units low velocity bottom area before the remaining effluent is introduced to the pretreatment clarifier, filtration and coalescing unit.

A mobile clarifier's technical aspect within its water recycling performance is the oil–grease separation from the returned blast water. Hydrocarbon molecules or their accumulative remnants (oil/grease) tend to adhere to oil–water separators coalescing plates or structure (polypropylene). Through accumulation developing buoyancy sufficient to overcome waste stream velocity by separating and shearing of floating to units top water plane is the function. At this point where effluent movement is maintained at zero disturbances, the first oil drain pipe is utilized or a skimmer system is applied removing the accumulated oil–grease concentrate. Equipment is also available providing repetitive fine coalescing treatment reducing remaining free oil dispersions. A fine oil filtrate establishes a hydro-tea suitable for various filter technologies polishing the remaining effluent for site-specific or

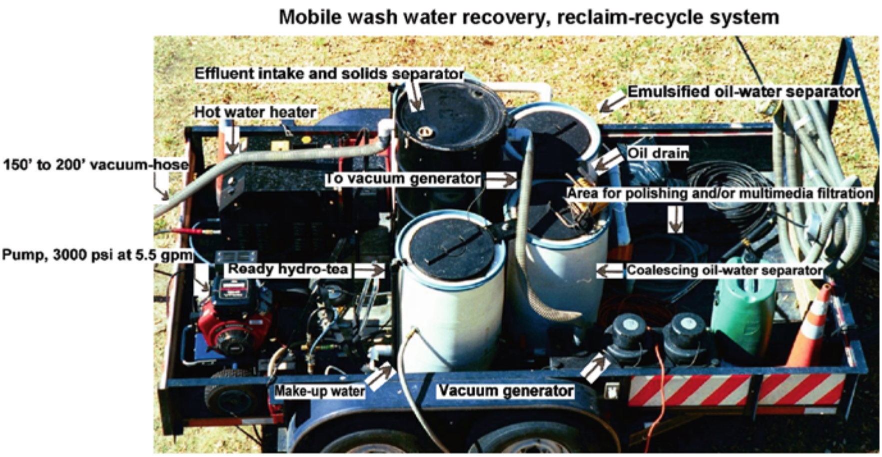


Fig. 3.293 200′ mobile wash water recovery, reclaim–recycle system

variations within the pressure washing or hydro-blast application field. Hydro-tea passing through a 5 μm filtrate can often be utilized for surface cleaning applications in areas where a high oil–grease residual can be expected. These areas are found on gas station–tollbooth–bank–restaurant drive-through operations or interior surfaces in machine-shops, vehicle or equipment repair facilities, which include produce, meat and/or agricultural manufacturing environments, etc.

Before any water release is introduced on a job site, water barriers must be arranged and covers installed to minimize the possibility of an improper or accidental discharge. First removing dry contaminants from surfaces by sweeping sand and gravel load is absolutely practical, minimizing the refuse accumulation within a sediment filtration chamber. Identifying the approved waste containers and avoiding sweeping these contaminants into adjacent storm drains will be noticed as professionalism.

Equipment pending, oil water separation can also be enhanced by eliminating low foaming detergents usually employed when removing heavy oil–grease accumulations by exerting higher psi performances to a surface. After bulk accumulations are removed a hot water application above 185°F can be quite effective in removing or reducing stain appearances within a surface interface.

Treating a surface with detergent before a pressure washing operation is introduced can result in producing an emulsion which is not only classifiable as a hazardous waste, but its makeup can significantly delay or alter dramatically any clarifiers-oil separation performance. The notion that an oil water separator, filtration and recycling unit can be adequate for all operations and encountered applications is false.

A mobile unit must be sturdy in its construction (Fig. 3.293) and provide a closed loop design, with the attribute of being covered, protecting against sloshing or spill out by rain or technical failure.

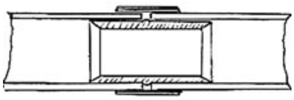


Fig. 3.294 Smooth vacuum hose interior

Fig. 3.295 Adjustable vacuum-shoe

Within commercial and residential application environments water supply can be limited, especially when operating more then one pump or rotary surface cleaner. A service provider will find that a mobile wash water recovery system is not only essential for its intended purpose and enhancement of application variety. Much more important is adding the capability to work in remote environments where only marginal make-up water is available.

A system should also provide the capacity of adding various polishing filters as deemed necessary, providing the all important application flexibility. Vacuum hose configurations should provide a smooth hose interior (Fig. 3.294), connection between hose sections also smooth avoiding hang up on corners which is always a problem when cam-lock fixtures are employed. The best method is utilizing duct-tape and metal sleeves between hose sections (Fig. 3.295).

Generally a rotary surface cleaner operates at 3–4,000 psi at 5 gpm plus, which is the basic configuration necessary for a filtration and recycling capacity in its simplest form. Therefore operating two units requires 10 gpm performance capacity. Float controlled fresh water supply is only utilized to replace water lost due to evaporation which in hot or parched dry climates can be up to 40%, especially noticeable when utilizing only 5 gpm on far-reaching surfaces as vehicle parking areas or gas stations, where a controlled gravity run-off can be 150′ plus. This also dictates the direction of cleaning operations, which will follow the natural flow of wash water. The cleaning capacity is 10,000 ft^2 hourly, utilizing the above-mentioned 5 gpm performance criteria. The oil–grease water saturation ratio relates directly to the equipment's filtration capacity which will reach a point of no return thus requiring treatment, evaporation or discharge to an approved facility to receive this hydro-tea.

When considering the challenge of removing a dissolved, soluble or emulsified product from its water constituents, technical limitations are quickly recognized and guiding (Fig. 3.296). How to remove dissolved tea from its water should be the appropriate and simple question for design engineers and practitioners when following their entrepreneurial technical instinct considering water filtration, flocculation and evaporation procedures.

Fig. 3.296 Hydro-tee

The required paperwork for environmental washing to contain, pick-up and pre-treat wastewater to legally release and/or discharge into a sanitary sewer or EPA approved septic and/or treatment facility is the written permission from a POTW or an owner of an EPA approved septic treatment system.

A service provider's written guide as to his washing practice identifying operational safety procedures, detergents utilized (MSDS), the major equipment engaged in the washing and recovery procedure, and how a jobsite is left after a job completion incorporating best management practices (BMPs) will usually guarantee a work permit. This criterion is also a major job-bid component, which should always be considered a companies front-line marketing endeavor within an environmentally correct pressure washing or hydro-blast procedure. Federal laws and regulations enforced by EPA and OSHA cannot be displaced or made lesser by any state, county or municipality. Federal laws can only be more stringent or enhanced in short, more comprehensively regulated by a state, county or municipality requiring a contractor to investigate the established municipality's guidelines possibly requiring a stricter and detailed job procedure.

It is also prudent to retain a copy of said job specific written environmental curriculum to a jobsite's paperwork and should include best management practices concerning this jobsite, reducing the possibility of work stoppage or interference by inspectors not privileged to this information beforehand.

Before any letter of acceptance or permit is issued by a regulatory agency a laboratory test of effluent in question will be necessary. A contract cleaner involved in repetitive surface cleaning applications, for instance provided by gas stations or any area producing excessive petroleum–hydrocarbon and greases–fats, etc. are most likely to provide such a test report.

Regulatory agencies are especially interested in wastewaters neutrality (pH 5–6), total petroleum hydrocarbon count (TPH) less than 100 mg/l, total dissolved solids in wastewater effluent (TDS), total suspended solids in wastewater effluent (TSS) less then 200 mg/l, its oxygen depletion (BOD) less than 100 mg/l, and chemical oxygen demand (COD) less than 200 mg/l including all heavy-metal

ranges below required limits and the daily wastewater volume generated. Educating a regulatory agency as to the actual low volume (gallons) of wastewater daily produced will reduce a possible misconception so often encountered in their decision-making process.

The necessary technology manipulating wash water away from its contaminants, creating semi dry residue or sludge with varying water concentration is a somewhat unpredictable aspect fluctuating with every job description. Identifying type and classifying the hazard in waste-products which are removed by high-pressure water from their respective surfaces, their physical semi dry or wet weight and volume will determine the technology necessary to concentrate, package and make ready for transportation. It is the waste concentration produced by effective removal, which will present a problem, not the possibly applied biodegradable chemistry in concentration.

The criteria for classification of sludge from wastewater and its disposal under the EPA standard identifying maximum contamination levels in title 40, CFR regulation 257 and general pretreatment regulations for existing and new sources of pollution part CFR 403, and CFR 503 for the use or disposal of sewage sludge is an important information base which requires a contractor's attention.

For disposal purposes, identifying the three main wastewater types is best achieved when confronted with a job description of a surface to be cleaned, its possible manufacturing or accidental process remnants-residual and location. For instance, soaking a wall with freshwater results in a non-hazardous water classification and wastewater which can be neutralized on site by neutralizing the acidic/alkalinity content of the wastewater may also result in a non-hazardous classification.

Today, seldom utilized specialty detergents containing a high phosphate constituent must always be contained and treated. Their release encourages rapid algae growths in ponds streams, rivers and lakes. Also it is important to study the detergents identification within the MSDS description to guard against accidental mixing of applied chemistry in any form containing chlorine bleach and ammonia products as hazardous fumes may be the result.

A wastewater stream containing solvents cannot be neutralized and must be treated, concentrated or evaporated. This category most often contains powerful acidic and/or caustic cleaners utilized while in new construction or in a restoration procedure. This can include wastewater carrying acids, detergents; paint-coating remnants found on various structural surfaces, etc. and may incorporate the lead abatement procedures by high-pressure water where phosphoric polishing filters remove lead elements from the recycled blast water. Creating this type of waste stream will most often be a job classification in itself where treatment and disposal costs are a part of the prospective bid procedure.

Today's wastewater source reduction technology renders its liquid remnants manageable for evaporation by incorporating pretreatment methods of the simplest or sometimes old and well documented or new sophisticated evaporation technologies. Wastewater evaporation is of an interest to a service provider in areas where volume of spent recycled wastewater has reached a saturation point where

the reduction by evaporation becomes a cost effective method. A stationary reclamation system may receive spent wastewater to further remove its water constituents producing a neutralized sludge residual which is stored in a sludge drying bed or is introduced to an evaporator process. High volume waste streams containing excessive levels of Mercury or PCBs and VOCs will require a permit from the local air quality authority.

Generally wash water sludge remnants does not contain such waste in measurable concentrations. Besides evaporation, flocculation can be of interest for some pressure washing and hydro-blast applications. There are many flocculants available which are admixed to a waste stream, coagulating suspended solids, which either will precipitate to the bottom or float to the top received by a filter cloth mechanism from its water constituents.

Bioremediation, utilizing aerobic microbes to digest oil and grease, electrocoagulation for wash water treatment, reverse osmosis systems separating water from its concentrate through a semi permeable membrane by force are technologies available to the industry but must also be measured with prudence as to validity, flexibility and practicality within a pressure washing hydro-blast application criterion.

The applied hazardous material cleanup technology by a power washing and hydro-blast application will always depend on identifying the characteristic of the industrial wastewater encountered or created.

Food, dairies, meat and poultry processing waste streams will carry dissolved and suspended organics, protein, lactose, blood, grease and fats, where equalization, aerobic or anaerobic biological treatment and screening, gravity separation, flotation, or coagulation–precipitation of their waste stream can be employed.

Breweries and distilleries, fruit and vegetable canneries create highly dissolved and suspended organics from natural products requiring screening, aerobic or anaerobic biological treatment, neutralization, gravity separation and centrifugation.

Plastics and resin manufacturing produces dissolved organics, including acids, phenolic, aldehydes, cellulose, alcohols, surfactants and oils utilizing gravity separation, flotation, coagulation, chemical oxidation, solvent extraction, adsorption and biological treatment.

Explosives manufacturing will produce organic acids and alcohols, soaps and oils manipulated by flotation, chemical precipitation gravity separation, macerating solids and biological treatment.

Leather tanning and finishing operations produce dissolved and suspended organics, fats and oils, organic nitrogen, hair and fleshy tissue manipulated by screening, gravity separation, flotation, coagulation, neutralization and biological treatment, etc.

Pharmaceuticals manufacturing processes are high in dissolved and suspended organics, including some surfactants and biological agents and require pretreatment by equalization, neutralization, coagulation, solvent extraction, gravity separation and biological treatment.

Textile manufacturing processes produce dissolved and suspended organics, fats and oils manipulated by equalization, neutralization, coagulation and adsorption, biological treatment and ultra filtration.

GEAR - LIST AUTHORIZATION

Wash water control, recovery, filtration, recycling, reclamation technology, evaporation

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:	
Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:
Job Description:			
Job Location:	Job Site Risk Assessment:	Specify:	©
Job Review Performed by:			
Parking lot: Multi floor parking facility: Sidewalk: Street: Storm sewer: Building exterior: Warehousing: Machine shop: Food processing: Industrial: Other:	Sludge type:	Hot water: Sludge drying bed: Holding tank: Clarifier: Ozone generator: Chlorination: Muriatic acid: MSDS: Soda ash: (sodium carbonate) " : Caustic soda: (sodium hydroxide) " : Chemicals: Specify: MSDS: pH test kit: Other:	
Equipment: Mobile wash water reclaim systems: Evaporator: Hydro-blast equipment: psi: Pressure washer: psi: High-pressure hose: 100' 200' 300' Hydro-vac system: Vacuum hose: 100' 200' 300' 400' Barrel vacuum-pump: Hose: 30' 50' Trigger-gun: Fan nozzle: 15° 25° 45° Wand extension: 4' 6' 8' Rotary surface cleaner: Rotary surface cleaner-vacuum shroud: Turbo-nozzle: Other:	gpm: gph: gpm: gpm:	Vacuum flange: Trailer clean-out mat: Drive on wash mat: Rail mat system: Sewer covers: Water barrier: 10' 20' 30' Vacuum hose: 100' 150' 200' Vacuum shoe: Tarp: Emergency sump-pump Rust-inhibitors, metering equipment: Permits: POTW: Other:	
Product hardness, adhesion, viscosity:		*Specify:*	
Fouling characteristics:		*Specify:*	
Physical surroundings, safety procedures:		*Specify:*	Other:
Describe application and work procedure:			
Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.			

Coke and gas manufacturing processes are high in phenolic, ammonia and dissolved organics, treated by equalization, flotation, adsorption and biological and chemical oxidation or solvent extraction.

Sludge treatment and its environmental considerations in terms of hazardous regulatory measure is best identified when listed under the RCRA, Resource

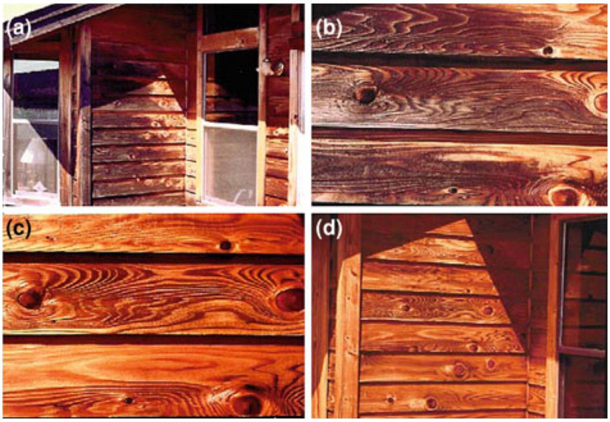


Fig. 3.297 **a** Damage by grill-barbecue fire; **b** close-up of damage, raised grain; **c** 45° fan jets at 3000 psi to 5 gpm; **d** dry appearance before staining

Conservation and Recovery Act, which is EPA's authority to control hazardous waste from cradle to grave, which includes waste generation, transportation, treatment, storage and disposal.

Applying chemical rinse aids such as surfactants, acid or base buffer–pH controller, stain or rust removers, water soluble organic solvents, phosphoric acid washes or rinses, chloride-salt removers and/or adding unidentified inhibitors to pressure-washing or hydro-blast water can greatly influence an existing sludge description and its classification, neutralization and its reduction technology. Chemical rinse or water additives are most often job and possibly site specific. Some additives or rinse aids may increase and some may decrease a corrosive emulsion or neutralizing characteristic. Their use and removal from a jobsite must always be tightly controlled and identified within a job procedure.

3.25 Wood Restoration and Preservation, Seal-Coating Applications, Wood Structures-Decks-Landing and Fence Restoration, Roof Asphalt-Composite Tile, Wood Shingle Cleaning, Vinyl, Wood, Aluminum Siding Cleaning

A customers desire or reason to clean or undertake a wood care process requires a detailed and correct evaluation of the exterior wood structure in question. The investigative job walk criteria must include the possible imaginative or suggestive perception as to customers foreseen and sometimes unattainable results by promising services and/or cleaning methods offered. Customers often relate to a muddled perception derived from various observations or personally witnessed

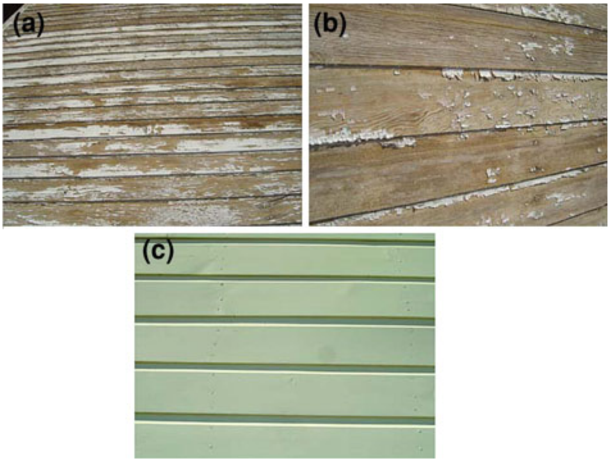


Fig. 3.298 **a** Deteriorated paint coating cover; **b** close-up of coating condition; **c** after jetting, dried, sealed and primed

results on similar structures devoid in consideration of any job decisive factors. The customers preliminary research efforts may enhance this dilemma as a result of scrupulous competitive services and/or chemical product sales endeavors. This can be challenging considering a service provider's business future greatly depends on customers' opinion and anticipation as to a final satisfying and long-term enduring result.

Professionals can quickly determine a customers position (knowledge) when identifying and describing the appearing problem and general type of pollutants found. The narration or service solution for obvious or hidden tough stains penetrating wood-façade surfaces and possibly their future preventive measure are best of an educational nature. Classifying algae, mildew and fungus growth, categorizing possible origination and preventive care and offering to prospective customers obvious and hopefully necessary added services will create an environment of confidence.

Offering these proven successful high-pressure-water application varieties to owners or authorized administrative clientele managing private and commercial residential structures can be an eye opening experience. These include the introduction of cleaning–washing applications for small or large ranch homes, bungalows, contemporary housing, log homes and their landings, decking, garage structures and driveways. The commercial identity includes rental and condominium properties, their driveways, parking facilities and possibly playgrounds, pool and party areas, their private marinas, horse or animal facilities.

Adding services to incorporate the cleaning of swimming pools, gutters and installing guards, minor repairs on landings or wooden decks and railings (resetting nail-heads and screws, etc.), concrete sealing–staining applications for driveways, pedestrian ways and garage floors, sealing–staining wood landings, decks, fences, gazebos and similar structures, or offering chimney cleaning, graffiti

removal, water abrasive blasting, hydro-vac, pipe and sewer cleaning services, and/or possible future crime and disaster cleanup procedures warrant the investment and service providers sales efforts. Also, besides introducing exterior wood care methods, the fire clean-up and wood restoration criteria can be of interest, especially in confined partially damaged areas. The education of customers to the capability proves or disproves the possible opinion that a high-pressure water cleaning method on wood is inadequate or destructive to wood surfaces. Wood, subject to fire, consuming its surface structure (Fig. 3.297), and subsequently developing heat activating and devouring tannins, sap and possibly various stain-coating residue will, within the flaming process expose its' grain (raised). Cured grain will not fray or create splinters protruding from its base when introduced to a fan jet manipulation and the following drying process.

The mere fact that a utilization of a qualified fan nozzle, and its specifically chosen gpm–psi configuration correlating to the necessary stand-off distance in consideration to encountered wood type and damaged burned interface zone is capable of bringing the underlying surfaces back to life is a persuasive argument. Reconstituted surfaces are either newly coated or only sealed with a deep penetrating and shielding wood stain preservative fortifying against long-term environmental and UV damages.

Beams and columns, the underside of decking and exposed joists, building siding, including a properties fencing are either installed in smooth, semi rough or rough appearances. These products are also called dimensional lumber. More often and price depending smooth surface wood is either finished with a coating procedure or varnished. Rough surfaces are treated, if at all, with a wood preservative incorporating exterior UV protection or coated with a flat appearing stain or varnish to visually enhance the texture of the surfaces.

Today the differences in wood products of identical description are often recognized when removing remaining coating from structures created in the early 1900s, which incorporated most often smooth surface boards and likely protection by means of a lead coating system. Also, these boards were generally manufactured from hardwoods, therefore perfectly suited for today's high-pressure water coating removal and hazardous lead coating abatement procedure (Fig. 3.298). The undesired raising of grain on these hardwood surfaces is, at worst, minimal as aged pine is also most often sturdy enough to be cleaned avoiding raising its grain structure. More over, in the past a building's prolonged exposure to the elements will direct to a significant change in application criteria also recognizing quite noticeable yesteryears product differences. Wood surfaces made susceptible by neglect or insufficient coating procedures developing rot or dry rot, wood board splitting and felting, mildew, mold and algae development in specifically prone areas, etc. demand a corrective and detailed preventive restoration procedure involving all infected areas. Under these circumstances surface irregularities, damage and the desired coating removal practice on a wood substrate will require a combination of restoration procedures within the application of the high-pressure water cleaning and/or paint-coating removal criterion. Restoration requirements may also change within the inherent differences of particular pieces of wood or the

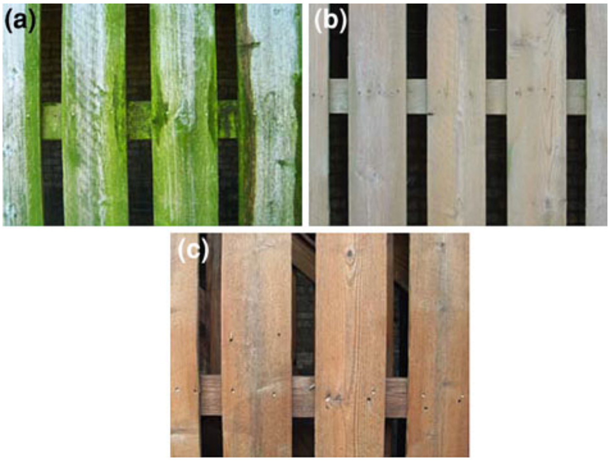


Fig. 3.299 **a** Mildew and mold infestation; **b** 25° fan jets 3000 psi to 2.5 gpm; **c** clean, treated, dry and stained

boards reacting accelerated to the environment producing adverse and advanced surface failures. Sporadic and/or firm coating adhesion between a healthy and damaged wood substrate-interface can also be broken chemically (strippers) diminishing further damage to the compromised remaining surfaces supporting a fan nozzle and vacuum head-brush assembly within a coating removal procedure and the following necessary surface neutralization.

The evaluation of an aged vertical exterior wall as to its suitability by cleaning with high-pressure water is quite simple. The experienced service provider can find the threshold limit between damaging and adequate cleaning performance within the interface structure by applying a pressure-scratch test with a tool of his choice. The alternative method is to apply a 25°–45° to 65° fan nozzles at various standoff distances to the damaged wood interface to be cleaned, testing various pressures and if possible, various water volume configurations similar to patch testing procedures on masonry and brick, block surfaces. It is not rocket science, rather logic combined with experience which will protect a wood surface in depth.

The correct evaluation of apparent stains and living organisms like mildew-mold and algae are as important as the source identification of stains introduced to wood surfaces in question, resulting from wax, grease, fats, iron and copper fixtures, tannins, tree sap and pitch, etc. To prevent reoccurring problems is it of an advantage to advice customer as to the contaminating source or circumstance of its structure.

Minor mildew and mold development such as is often found in humid areas can be removed with sodium per-carbonate based wood cleaner especially when applied after an initial cleaning procedure. Substantially infected wood surface areas are first subjected to a high-pressure water cleaning procedure. Permitting an adequate drying time prior to a treatment with two to four parts of water to one part

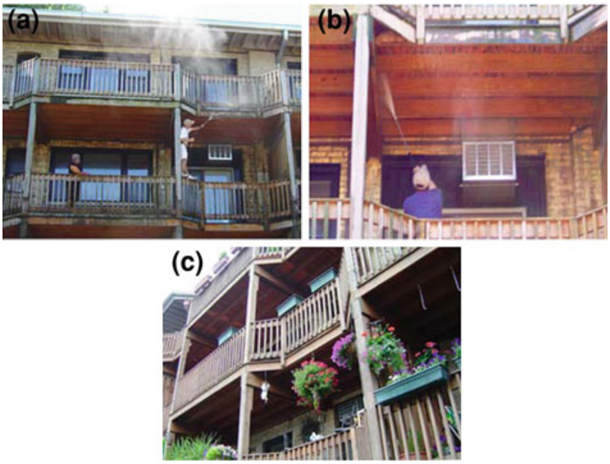


Fig. 3.300 **a** Moss, fungus, insect infestations; **b** rafter cleaning, pest control; **c** cleaned, dried and stained

of chlorine bleach on aforementioned heavily infested wood surface is of an advantage. It is also important to permit a dwell time of the bleach solution, which should be a minimum of 20 min in a wet-humid stage. Neutralizing the surface with an oxalic based wood brightener following the final rinse procedure will produce an optimal result.

When assembling a job-gear list, is it also helpful to identify the encountered wood type and possibly its age, and origination. Today siding and fencing are mostly manufactured from softwood such as pine, fir, cedar or spruce. Cedar and redwood board will dissolve some tannin when pressure washed, visually identifiable by yellow brown staining on weathered and naturally bleached wood surfaces. This is only marginally problematic when a cleaned fence board is not stained with an appropriate wood preservative hopefully incorporating a UV protection. This tannin release can also be accelerated by the incorrect use of strong alkaline based solutions. The stains can be removed by an oxalic acid based wood brightener neutralizing the alkalinity within the wood, drawing the tannic acid away from surfaces (Fig. 3.299).

Decks-porch-staircase-landings and their preservation–restoration methods are often underestimated in necessary effort and product consumption due to their overhead and vertical components such as railings, simple or intricate spindle and balusters. Materializing rust and copper stains caused by nails, decorative metal fixtures or garden furniture and oil-fats, waxes absorbed in various deck areas introduced by grilling, kerosene spills and dripping candle wax are all mitigating factors. Over-head components like rafters and open underside of decking may entice operators to begin an unsafe operating procedure (Fig. 3.300) in their attempt to reach all corners and hidden surfaces. When performed correctly the job-walk and description present almost always an eye-opening experience to the

property owner for its necessary cost requirement. Starting with the removal of accumulated grease stains, probably organic oils and animal fats (grills), which often penetrate deeply into the decks surface, requires a repetitive treatment with 1000 psi hot 200°F water temperature heating the stained surfaces in the attempt to draw and eradicate reappearing oils from the pores or sponge like interface zone utilizing a detergent to emulsify rematerializing oil–fat remnants. Permitting a repetitive drying time between applications is of an advantage especially before a sodium hydroxide based solution is applied in the attempt to reduce the often diminishing but reoccurring stain formations. The successful hydroxide application must be neutralized from all wood surfaces with an oxalic acid based wood brightener which also neutralizes the tannins acid that has been drawn to the surface. In totaling overall surface cleaning and prep time s followed by a desired wood staining–coating and/or preservation procedure is it clear that job criterion and pricing can quickly escalate.

When removing a deteriorated exterior stain–varnish product, it is of importance to first identify the adhesive quality of the binding resin of the remaining coating residual. In general deteriorated stains are highly susceptible to high-pressure water introduced by a rotary surface cleaner. Testing the removal effectiveness is simple and should not be steered by a pending chemical sales criterion.

Subject to wood type, hardness and/or presence of surface deterioration necessary applicable pressures may range from 1000 to 4000 psi, at 2.5–5 gpm, hot and/or cold water.

When a total removal scenario cannot be guaranteed by utilizing high-pressure water only, the following hazardous removal criteria, employing a free caustic application to the varnish remnant enhances deletion effectiveness greatly. The introduction of a high-pressure water procedure to a dry, porous wood surface (boards and/or logs) penetrating the existing crevices or fissures within the wood substrate permit a measurable moisture saturation and absorption application preferably to above 20% moisture content. The degree of absorption can further be controlled when manually operating a vacuum assist rotary surface cleaner, providing a direct water recovery. This absorption is a vital function, especially when a job criteria calls for the utilization of un-buffered or free caustic treatment applied to the woods surface, designed to soak through, the exterior finish and the wood's stain-coating interface. The water saturation penetrates and swells pores hindering the uncontrolled deep absorption of the damaging caustics. Calculating the timeframe between treatment of high-pressure water and caustic application and its dwell time should always be a controlled requirement. Caustics cannot be neutralized by water but can be blocked within an engorged porous area where access to liquid acidic neutralization is not denied in depth by shrinkage to the present caustic elements. Wood products, such as cherry, mahogany, oak, redwood and cedar contain a high amount of tannic acid which can be drawn to the surface when correct neutralization of the substrate is not achieved (pH 7). Especially when dormant chemistry is reintroduced to humidity will surface discoloration reappear. Newcomers to the industry are best advised to apply buffered chemistry

Fig. 3.301 **a** Overhead wood cleaning; **b** 2 × 45° fan jets 3000 psi to 5 gpm; **c** dried wood surface before staining

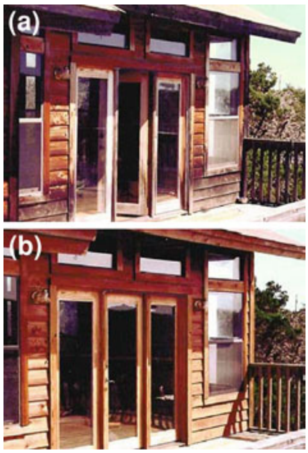


Fig. 3.302 **a** Weathered wood-façade; **b** wood-façade cleaned, dry, before staining

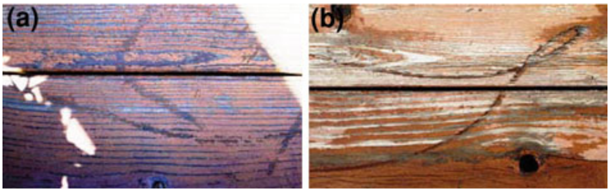


Fig. 3.303 **a** Wood damage round jet, wet surface; **b** wood damage round jet, wet surface

controlling the pH criterion of a specific cleaning–restoration procedure. Much can be learned when following manufacturers' guidelines.

Log home washing, sealing and/or restoration procedures present an application variety which requires a personal and specific marketing strategy.

Log-house owners are finding it difficult to identify qualified service companies restoring and maintaining their homes. The novice service provider will find it difficult to relate to the needs and desires' a log home owner identifies. Due to specific environmental circumstances, or sometimes a lifestyle oriented criteria the customer requires a unlike job prerequisite in comparison to the proud owner of a city or suburban tract home. Most often is a water filtration, recycling capability very welcomed and identifying job quality as is the inherent equipment capability to operate with fluctuating water supply below 5 gpm due to the rural location of many homes. In many areas log home manufacturers have applied inferior wood treatment, coatings or varnishes to their product later ultimately responsible for premature failure in their unforeseen given environment. Coating companies identified this new emerging market selling products based on a UV protection and water repellency but lack the capacity to control or describe variations of surface and substrate preparation often resulting in an incorrect coating or varnish installation. The prior cleaning, which is best and most effectively performed with high pressure water on interior and exterior surfaces (Fig. 3.301) removing sap and airborne contaminants especially on the top-side of logs, where accumulating contaminants retain humidity providing a fertile environment for moss, mold and algae etc. Periodically performing surface maintenance correctly by washing and rinsing a log home is quite a simple affair achieving the necessary surface cleanliness and acidic neutrality equal to logs neutral pH 7 prior to a probably oil based, solvent borne and penetrating replenishment.

It is important not to subconsciously be lured into discounting the guarding against moisture intrusion to solid appearing doors and window frames, roof overhangs, underside and eave components which are probably manufactured from hardwood veneer but bonded to a solid or hollow core structure. Buildings may incorporate a variety of components not of solid nature and therefore more sensitive to humidity.

The problem starts when coating maintenance procedures have been neglected over an extended period of time. Environmental influences can separate wood cells in various unforeseen areas from their substrate. These wood fibers cannot retain a stain or coating application (Fig. 3.302).

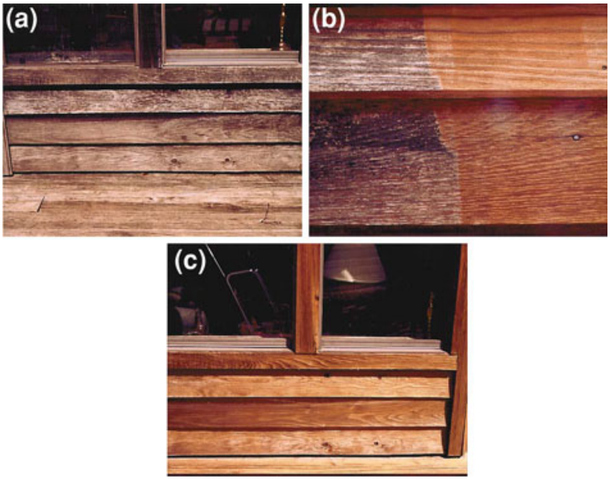


Fig. 3.304 **a** Weathered wood-façade; **b** wood surface before and after; **c** surface before staining

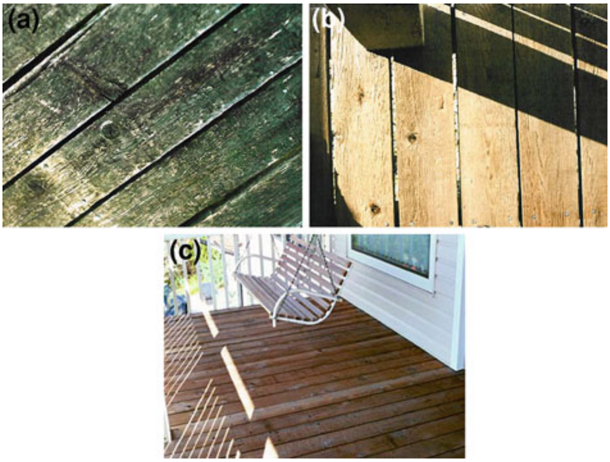


Fig. 3.305 **a** Floor boards, weathered—mold; **b** floor boards, clean, dried before staining; **c** boards, before staining

Besides determining the correct psi–gpm configuration correctly testing the coating or varnish stripper is of utmost importance. Creating test patches on shady and sunny sides are as vital on structures environmental impact zones where wind, rain and ice have varying seasonal surface influences and must be performed and correctly evaluated. Experience has shown that this is best done before an overall job estimate is established. Performing this test patch criteria also permits the evaluation as to necessary protection of landscaping, covering or removal of light

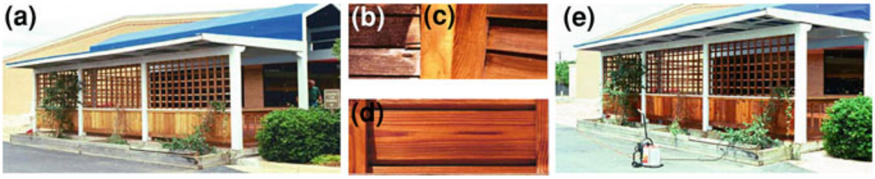


Fig. 3.306 **a** Building-façade after cleaning and dry; **b** before; **c** after-dry; **d** stained; **e** building-façade after drying, within staining process

Fig. 3.307 **a** Weathered floor boards; **b** 2 × 45° fan jets 3000 psi to 5 gpm; **c** surface cleaner (Spin-Jet); **d** before e after

fixtures and various metallic hardware, masking windows, possibly require scaffolding and/or lance extensions, checking for possible inherent dangers such as live electrical wiring, pedestrian traffic, possible windswept influence of coatings on surrounding structure or vehicles and considering the final job cleanup procedures of possible accumulated hazardous waste and its correct identification, storage and transportation to the appropriate facilities.

Log homes are often accompanied by wooden decks, terraces, and staircase structures supporting the design criteria of the main buildings architectural identity. Deck staining, sealing and water proofing most often includes servicing and incorporating railings, spindles and staircase structures. Transforming decks to a pristine condition is most often required when an overall renovation is in progress.

In their endeavor to save money homeowners frequently attempt to service their decks, underestimating the qualifications a professional high-pressure water application specialist requires within the wood cleaning, preservation and restoration criteria. Renting the necessary equipment and learning on the go often results in damage visually identifiable as a surface discoloration, recurrence of mold and fungus, ghosting and wood carving and/or rising of the grain in their attempt to clean or possibly remove coatings. The severity of occurring damages (Fig. 3.303) can be more visible or enhanced when surfaces are in a damp to dry stage. Identifying wood variety and type, the degree of surface deterioration, overall tool access to surfaces in question, blast water quality and mineral makeup, and securing a functional up or downstream chemical injection is a professionals

criterion. Also nozzles, rotary surface cleaner and spin-jet varieties, water recovery, filtration and recycling necessities are tool entities seldom available at an equipment rental facility. This especially is noticeable when researching equipment availability offered by shops for wood stain, coating and restoration treatment products supporting their product sales efforts. A property owner must understand that a qualified surface preparation is managed and achieved by a qualified tool operator understanding the substrate, and its challenges to be prepared for a coating procedure.

Removing the gray appearance of aged wood siding and deck-railing surfaces (tannin) represents the simplest form of a wood cleaning procedure. A trigger gun mounted manually operated 25° fan jet applied in corners and on spindle and railing work, a rotary surface cleaner with dual 15° to 45° fan at varying psi–gpm performances, most often eliminates the application of phosphoric and oxalic acids, avoiding the application of neutralizing endeavors.

Always permit adequate substrate drying time and be sure that the weather report is favorable before stain and/or penetrating water repellent oil based solvents incorporating UV protection are applied by roller, airless or pump-up sprayer. Allow for penetration time and wipe off excess product and apply brush, avoiding irregular product loading. Provide pictorial samples after pressure washing only and before staining. One after first staining application is shown (Figs. 3.304, 3.305, 3.306).

Cleaning composite and ceramic tile, asphalt, cedar, and/or metal roof shakes-shingles is ordinarily a simple endeavor often incorporating an advantageous gutter system to collect and operate a wastewater recovery, filtration and recycling unit.

"*Roof safety*" All operations above 6′ ft from the ground are subject to contractors' safety and best practices concerning fall protection. OSHA CFR29 1926.500 and roof safety subtitles are the information base explaining the must do requirements. Safe access to roofs by ladder or any other method is a controlled criterion, which requires training in correctly operating personal protective equipment (top entrance harness, lanyards-lifeline, etc.,) and testing as it requires a safety man overseeing operations. Roof design varieties, placement of roof anchors, and various access methods accommodating the operation of rotary surface cleaning equipment, spin-jet and trigger-gun or fan jet assemblies will vary with every job description. These safety requirements are not confined to a roof surface in question, but must incorporate the whole jobsite including possible influence of surrounding vicinity. Access specialization utilizing high-pressure water tooling and wastewater recovery recycling and filtration systems are a most exciting and lucrative endeavor.

The roof cleaning application and its job potential depends on geography and climate. In the Seattle or Portland, Oregon area mosses, mildew and algae are the contaminating source to roof surfaces.

In an industrial city like Chicago, weather cycling and general air pollution (Fig. 3.307) and its acidity is responsible for discolorations and fungus development and in dry areas such as New Mexico the roof cleaning business is quite none existent.

Nevertheless 90% of US homes feature asphalt shingle roofs. Modern shingles are manufactured from organic based fibers or glass-fibers of varying lengths and orientation creating a substrate impregnated with various bituminous–asphalt products and protective mineral granules providing texture and color themes. The disadvantages of these roofing products are sensitivity to physical impact or stress, especially on high heat or very cold days and the susceptibility of bitumen–asphalt to improperly applied cleaning chemicals which is best altogether avoided. Dirt–dust and other organic materials deposited by rain accumulating on low velocity roof surfaces become the breeding ground for algae type spores. Spreading and decomposing algae or fungus is the culprit which discolors a roof surface. A black striking stain development is most likely gloeocapsa magma algae found on asphalt and metal roofs.

A rotary surface cleaner incorporating rpm control and a hover-craft like lift permitting unidirectional operation gliding (Fig. 25.10) over irregular shingle surfaces is the ideal tool configuration for this or other roof cleaning operations. Neutralizing the equipment's weight and mass, nullifying lifting of shingles, incorporating finger light unidirectional control in an often somewhat physical precarious situation can not be replaced by any other tool configuration. Psi–gpm configuration is best adjusted to the low-end of granular adhesion and manipulated by 45° fan nozzles, providing removal of discoloration or bacterial growth only by adjusting the nozzle angulations' to the surface (only). After the cleaning procedures are completed and surfaces are flooded with an preventive chemical rinse from the bottom up and after their recommended dwell time neutralized, advise customer to install copper or zinc strips on top layer of asphalt shingles. Rain wash introduces small amounts of copper poisoning–killing reoccurring bacteria.

Tile roofs are more prevalent today. The lightweight surface cleaner again is the ideal unit. The application of chemicals should only occur if a dialogue with tile manufacture can be established as to the appropriate chemical solution, protecting the tile glaze. The notion that a tile glaze is susceptible to damage introduced by a surface rotary cleaning unit again is a myth perpetuated by competitive chemical salesman.

Cedar–redwood, white pine-cyprus, etc. shingles are cleaned utilizing the same equipment but the chemical application, and preservation varies drastically by area, humidity, temperature, wood type, past treatment and present surface degradation, etc. Never, ever start cleaning procedures from the bottom up because water will penetrate to the roof sheeting or worse. There also is little protection and physical hold applied to a shingle system inviting damage by lifting and stepping on. Moss protruding into shingle structure must be removed, and varying by location, molds identified for the correct topical roof treatment and the application of suitable wood preservatives. All materials must be accompanied by MSDS sheet identifying ingredients and safety precautions. Chemicals work most effectively when only trace elements are left to be removed or treated on a dry substrate, if not otherwise explained. Do not apply unfortified linseed oil, fire retardants, the waterproofing sealants or plasticizers. The Cedar Shake & Shingle Bureau (www.cedarbureau.org) is a resource as to roof design, shingles or shake

type, identification of mold-fungus procedures, etc. Today, in countless communities, plastic-vinyl siding and trim is also applied as architectural construction, such as downspouts, gutters, window frames and fencing, etc.

Inherently these products are all susceptible to static bonding of dirt and air-borne particles. The wide variety of manufactured vinyl siding also greatly varies in product quality. Porosity and/or composition of siding is drastically varying with exposure to sunlight (fading) and increased heat absorption resulting in inconsistencies ranging or exhibiting flat to glossy surface appearances (dull). Always check the building for missing and loose panels, and choose non penetrating application criteria avoiding water seepage to the interior. Customer must know and be aware of pre-existing damage and structural problematic preferably signing off a disclaimer before a cleaning procedure commences. After first thoroughly and repeatedly soaking vinyl surfaces and buildings immediate vicinity (foliage) apply a mild biodegradable cleaner to vinyl surfaces followed by a manual surface agitation (pole brush) immediately followed by applying the low pressure rinse avoiding lifting of siding components. A 45° fan nozzle at 500 psi 3–5 five gpm is most often sufficient. Apply rinse jet in downward motion avoiding water penetration from bottom up. Air velocity alone may damage vinyl panels, or send water to the interior. It is best to start working on the shady side of the building in progression to the sunny side expanding the water wetting and reducing chemical dwell time. To avoid streaking, the job sequence generally starts on the bottom of the structure. Vinyl's structural susceptibility to heat will keep operating temperatures below 135°F. Areas prone to mildew, infestation, noticeable and obvious especially on vinyl sidings light in color is removed by jetting and followed by a light sodium hypochlorite solution (bleach) applied to the prior infected areas. It is best to avoid the penetration of any cleaning solution to the backfill-surfaces of siding avoiding stain leaching to cleaned surfaces. Oxalic acid can be useful for rust stains, but must be applied with caution. Artillery fungus, a stubborn problem and best carefully challenged with hot water and a spin jet nozzle at reacquired pressures avoiding damage to vinyl. Areas prone to stain and dirt accumulation such as for instance mildew development in the vicinity of attic vents, on top of window-molding and door sills, soffit areas, vinyl under or behind balconies and decks are job specific, as are gutters, down-pipe and spouts, window screens and shutters which must all be considered in the bidding process do to possibly intensive time consumption within the overall cleaning process. When aware this is of no consequence; cleaning vinyl siding is one of the least difficult application criteria within the general house washing field.

The aluminum siding business, once prominent, is today virtually nonexistent and includes the ever fading remaining buildings to be serviced. No one building can be compared to another or similar application criterion. Surfaces are painted and oxidize with time requiring a careful analytical application criterion as to chemistry and water pressures applied. Most often a two step cleaning process is necessary in applying systematically and equally a buffered acid solution, followed by a high alkaline soap solution to neutralize all surfaces. The first step when cleaning aluminum siding is to check for oxidation. Direct sunlight accelerates the

GEAR - LIST AUTHORIZATION

Wood restoration and preservation, vinyl, wood, aluminum siding and roof cleaning

Customer & Company: Web site: e-mail:	Date: Job Nr.: Address: City: P.O. Box: State: Zip Code:

Purchasing: Tel: e-mail:	Engineering: Tel: e-mail:	Maintenance: Tel: e-mail:	Safety: Tel: e-mail:

Job Description:

Job Location: Job Site Risk Assessment: Specify: ©

Job Review Performed by:

Deck-landing-staircase-railing-roof Siding: aluminum wood vinyl fiberglas Spruce: Pine: Fir: Cedar: Redwood: Other:			Dimension lumber: Shingles-shakes: asphalt tile wood composite metal Rough surfaced: Smooth surfaced: Deterioration: mild: aggressive: Explain: Other:		

Stain type: soluble tannins, sap, pitch, moss, mold, fungus, fire, graffiti, bird-bug-pest droppings Spot cleaning: Time: Authorized:	Other: Overall square footage to be serviced:

Existing structural damages: (explain)			Safety procedures: (explain)		
Litmus paper: (pH) Substrate-surface moisture meter: Blast water source: Blast water discharge:	 lbs: yes	 gpm: no	Acid treatment: Acid neutralization: Detergent: Surface pH: Other:	MSDS: " "	

Equipment: roller, pump-up, airless sprayer

Penetrating wood preservative: Semi-transparent stain: Solid color stain: Deck stain for previously stained decks: Exterior deck stain solvent based: Protect from water intrusion:	Water filtration and recycling: Rotating surface cleaner: vacuum-support: Spin-Jet: Extension wand: 6' 10' 12' Telescopic wand: Trigger-gun: Fan nozzle: 15° 25° 45° 65° Protective skirting-cover:

Describe application and work procedure: Overall height-with: Scaffolding: Man lift:

Itemize further equipment, safety gear, expendables, labor time, equipment times, etc.:

Environment: Industrial Commercial Residential

GEAR - LIST Nr.

Customer & Company: Web site: e-mail:		Date: Job Nr.: Address: City: State:	P.O. Box: Zip Code:
Purchasing Tel: e-mail	Engineering Tel: e-mail	Maintenance Tel: e-mail	Safety Tel: e-mail
Job Description:			
Job Location:	Job Site Risk Assessment:		Specify: ©
Job Review Performed by:			

Building type:			Pressure washing - Hydro-blast equipment:		
Non-expendable equipment:			Expendables:		

Product Encountered:			
Hazardous Material:	MSDS:		Specify:

Safety procedure:

Work procedure:

Developed by: Date:
Authorized by: Date:

paint chalking or paint oxidation processes. Surfaces exposed to industrial pollutants, airborne dirt such as auto exhaust and building type pending rust stains, mildew and fungus might al be an accumulative present criterion. Dark aluminum siding, such as dark red or blue is also washed from top down preventing the greater tendency to streak especially important in hot weather. Sealing this type of surface is important extending the longevity of achieved surface appearance. Required equipment includes safety glasses, chemical gloves, chemical suit, hard hat, first aid kit with eyewash, wooden-metal paddle scraper, long-range chemical-acid injector, buffered acid solution, alkaline soap, MSDS sheets, pole brush, various aluminum wands and telescopic wands, 25°–45° and 65° nozzles, variable speed rotating nozzles, duct tape and plastic sheeting for masking windows, doors and foliage. Within exterior building cleaning procedures bird droppings-excrement can be encountered in various locations, which are either nesting or habitat locations which must be considered hazardous waste. A number of illnesses to include cryptococcus, histoplasmosis, and psittacosis are associated with dry bird droppings primarily those from birds in areas of nitrogen rich soils, pigeons and bats. The primary mode of transmission of these diseases to humans is via inhalation of disease causing spores-organisms. Personal protective gear, respirator NIOSH approved protection below 0.3 μm, is a must. Misting down-wetting the area of contamination limiting airborne activity before a removal process is initiated or area inspections for demolition work, restoration of historic and/or abandoned buildings is performed. Infected areas, especially in areas or vicinity of food source manufacturing, and a storage facility is this hazardous waste removal criterion regulated.